THE

EDINBURGH

PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF

THE PROGRESS OF DISCOVERY IN NATURAL PHILOSOPHY, CHEMISTRY, NATURAL HISTORY, PRACTICAL MECHANICS, GEOGRAPHY, NAVIGATION, STATISTICS, AND THE FINE AND USEFUL ARTS,

FROM

OCTOBER 1. 1822, TO APRIL 1. 1823.

CONDUCTED BY

DR BREWSTER AND PROFESSOR JAMESON.

TO BE CONTINUED QUARTERLY.

VOL. IX.

EDINBURGH:
PRINTED FOR ARCHIBALD CONSTABLE AND CO. EDINBURGH;
AND HURST, ROBINSON & CO. LONDON.

1823.

THE

EDINBURGH

PHILOSOPHICAL JOURNAL.

ART. I.—*Biographical Memoir of Count* CLAUDE LOUIS BERTHOLLET *

THE name of M. Berthollet has been [illegible] part of Europe, and cannot fail to occupy a high place among the distinguished chemists of the nineteenth century. He was born at Taloire in Savoy, on the 9th December 1748, and, like his distinguished colleague M. La Grange, he was an Italian by birth as well as by education. After having taken his degree of Doctor of Medicine at the University of Turin, he went to Paris, where he carried on the medical profession with so much success, that he was nominated one of the Physicians of the Duke of Orleans, the uncle of the reigning Sovereign. Notwithstanding the excellence of this appointment, he seems to have devoted the greatest part of his time to the study of chemistry, which soon became his exclusive occupation.

The brilliant discoveries which had been made by Black, Priestley, Scheele, and Cavendish, formed the elements of that grand revolution in chemistry, which was completed under the direction of Lavoisier. In this great work the French chemist was associated with Fourcroy and Berthollet, the one distinguished by his eloquence and his powers of illustration, and the other by his sagacity and his experimental acquirements. As

---

* For some of the facts in this hasty and imperfect sketch, we have been indebted to a short life of Count Berthollet, by M. Auger.

the limits of this notice will not permit us to analyse the various memoirs which Berthollet communicated to the Academy of Sciences and to the National Institute, we shall content ourselves with a general view of the discoveries which they contain.

One of the earliest and most important subjects to which Berthollet directed his attention, was the analysis of Ammonia, the nature and the proportion of the elements of which he determined with a degree of accuracy which later researches have scarcely been able to improve. He resolved the pure gas into its elements, by making it pass very slowly along an ignited porcelain tube, of a small diameter,—a method which has been more recently practised by Gay-Lussac. In finding ammonia in the products of animal substances, he was led to consider the presence of azote in organised bodies as the distinctive character of animality, and thus to make an important step in animal chemistry. This valuable memoir was published among those of the Academy of Sciences for 1785 *.

The observations which Scheele had published on the prussic acid, and its different combinations, though in every respect fine and interesting, were yet insulated and incomplete. M. Berthollet resumed the subject with peculiar success, and recognised in it a compound acid, in which oxygen did not exist. The next researches of our author related to the combinations of sulphur with hydrogen; and though the new views which arose out of this inquiry met with considerable opposition, yet they were soon universally adopted.

One of the most important discoveries by which M. Berthollet is distinguished, is that of the application of the oxymuriatic acid to the purposes of bleaching. This acid was discovered by Scheele, but its properties were made known principally by the labours of our author. The application of this acid to the purposes of bleaching was discovered by Berthollet about the

---

* In consequence of Sir Humphry Davy having stated it as his opinion, that oxygen was one of the constituents of ammonia, A. B. Berthollet, our author's only son, afterwards analysed this gas, and confirmed the results previously obtained by his father. M. Berthollet sen. had found its composition to be 72.5 hydrogen, and 27.5 azote, whereas his son found the oxygen to be 75.5, and the azote 24.5. The memoir of M. Berthollet jun. was read to the Institute on the 24th March 1808.

year 1786. Some of his experiments, of which he made no secret *, were exhibited to our late distinguished countryman Mr Watt, who immediately saw the importance of the discovery, and some time afterwards actually applied it in whitening 500 pieces of cloth. In the beginning of the year 1788, some foreigners attempted to obtain in England a monopoly of this valuable process, but their application for a patent was resisted by Mr Watt, and by Mr Cooper, and the late Mr Henry of Manchester; and the two last of these gentlemen formed the first establishments in which this great discovery was first applied on a large scale. The great improvements in this process, which were subsequently made by our countryman Mr Tennant of Glasgow, in combining the oxymuriatic acid with lime, and in forming a portable bleaching salt, by uniting the gas with dry quicklime, have increased the value, and widely extended the utility of Berthollet's discovery.

The combinations of the oxymuriatic acid with the alkalies, though equally interesting in a scientific point of view, have not yet found the same useful applications. The experiments of Berthollet on the oxide of ammoniacal gold, made us better acquainted with this dreadful compound, though its effects are still less frightful than those of the fulminating silver, which he discovered soon after, and which explodes violently, even by the percussion occasioned by a drop of water falling upon it.

In the examination of these compounds, our author seems to have been led to those experiments, by which he has conferred on the art of dyeing as great a benefit as that which he rendered to the kindred art of bleaching. Hitherto that branch of the useful arts consisted of the most absurd receipts, and was founded upon the most ridiculous theories. Hellot, Macqueer, Bancroft and Bergman had indeed begun to renovate the art of dyeing. Mr Keir and Mr Bancroft appear to have been the first, who suggested the true theory of mordants; but it is to Berthollet undoubtedly that the complete establishment of the theory belongs.

* The only advantage which Berthollet derived from this great discovery, was a present of a bale of cotton stuffs bleached by his process, which was sent to him by an English manufacturer. This fact is stated by M. Auger. It is probable that they were sent by Mr Watt.

Upon the death of Macquer, Berthollet succeeded him in the situation of superintendant of the arts connected with chemistry, and so zealously did he devote himself to the objects of this office, that almost all the papers which he inserted in the "*Memoirs of the Academy*," in the "*Journal de Physique*," and in the "*Annales de Chimie*," relate principally to the promotion of the chemical arts. In the year 1791, he published his "*Elemens de l'art de Teinturier*," in one vol. 8vo.; and a second edition of it, greatly improved and enlarged, was published in 1814, in 2 vols. 4to. This treatise has always been regarded as a standard work, and, along with the practical processes of the art, it contains the clearest theoretical views of the principles upon which these processes depend.

In the year 1776, M. Berthollet published a separate work, entitled "*Observations sur l'Air.*" In 1780, when he was only thirty-two years of age, he was admitted a member of the Academy of Sciences. In 1789 he published a work under the title of "*Precis d'une Theorie sur la Nature de l'Acier, sur ses Preparations*," &c. In 1792, he was named one of the Commissioners of the Mint. In 1794 he was appointed a member of the Commission of Agriculture and the Arts; and, about the same time, he was chosen Professor of Chemistry at the Polytechnic School, and also at the Normal School. At the establishment of the Institute in 1795, he held a prominent place in the list of this learned body; and, in the same year, he published his "*Description de Blanchissement des Toiles.*"

In consequence of the subjugation of Italy by the French arms, Berthollet and Monge were appointed deputies by the Directory, to select those objects of the arts and sciences which ought to be transferred to Paris. In the execution of this task, General Bonaparte became acquainted with their zeal and knowledge; and such was the high opinion which he formed of them, that he induced them to accompany him, in 1798, in his unfortunate expedition to Egypt. In that country they distinguished themselves by their zeal in relieving the wants of the French army, and by their activity as the leading members of the Institute which Bonaparte had established at Cairo.

Upon their return to France, in 1799, with Bonaparte, they were both honoured by the First Consul with the task of

members of the Conservative Senate, and each of them was afterwards provided with a senatorerie.

When the French throne was re-occupied by its legitimate Sovereign in 1814, Louis XVIII. appointed Berthollet a member of the Chamber of Peers; and, from attachment, no doubt, to the Bourbon Family, he took no part in the Chamber which Bonaparte had organised, after his return from Elba.

A short time after he returned from Egypt, M. Berthollet took up his residence at Arcueil, a village about three miles south of Paris, where he pursued, in peaceful seclusion, those fine researches which adorned the close of his philosophical career. The results of these labours were given in his "*Recherches sur les Lois de l'Affinité*," which appeared in 1801, and in his "*Essai de Statique Chimique*," which was published in 1803, in 2 vols. 8vo *.

While our author was thus extending the boundaries of chemistry, by his own immediate labours, his rank in society, and his means of liberality, enabled him to become an active patron of scientific men. At the village of Arcueil, distinguished as the residence of that illustrious individual the Marquis Laplace, Berthollet established, in 1806, the *Society of Arcueil*, which met in his own house, where he formed a cabinet of physical instruments for the use of its members. This Society consisted of the Marquis Laplace, Count Berthollet, M. Biot, M. Humboldt, M. Thenard, M. Decandolle, M. Collet-Descostils, A. B. Berthollet, and Malus. They have published three volumes of their Memoirs, entitled "*Mémoires de Physique et de Chimie de la Société d'Arcueil*," the first of which appeared in 1807, the second in 1809, and the third in 1817. At the meetings of this Society, which took place every fifteen days, new and interesting experiments were repeated, memoirs upon different subjects were read by the members, and each of them was charged with the perusal of several journals or works, connected with the particular

* Besides the works now mentioned, Berthollet translated "*Kirwan's Essay on Phlogiston*," and added notes, in which he controverted the opinions of the English chemist. He was the author also of a preliminary dissertation and notes, which accompanied Riffault's translation of "*Dr Thomson's System of Chemistry*," which appeared at Paris in 1808.

science which he cultivated, and the report upon these works was communicated to the Society. "Celui qui a conçu," says Berthollet himself, "le projet de former cette reunion, y trouve, en voyant approcher la fin de sa carriere, la douce satisfaction de contribuer par cette pensée, aux progres des Sciences auxquelles il s'est devoué, beaucoup plus efficacement qu'il n'auroit pu le faire par les travaux qu'il peut encore se promettre de continuer."

This interesting association, kept together for a while by the amiable character, and the eminent talents of its founder, seems to have speedily declined, and probably owed its declension to that dreadful event, which deprived Berthollet of his only son, and the association of one of its most eminent members. The death of A. B. Berthollet, by his own hands, could not fail to throw a shade over an institution so closely associated with his afflicted family. The writer of this hasty sketch had the high satisfaction of meeting with Count Berthollet, at the country-house of his friend and neighbour the Marquis Laplace at Arcueil, and will never forget the intelligence and benignity of this interesting man. The late celebrated Mr Watt, with whom he kept up a constant intercourse, entertained for him the purest friendship, and we have often listened with delight to the sentiments of respect and affection which he always expressed for the French chemist.

At the advanced age of seventy-four, this eminent man suffered much from a number of boils, followed by an abscess of uncommon magnitude, which occasioned great suffering. A fever, however, which ensued, carried him off, after three days continuance, on the 6th November 1822, the same year in which the Sciences were deprived of Herschel, Haüy, and Delambre. M. Berthollet left behind him an aged widow, who had devoted her life to ensure the happiness and tranquillity of her husband.

Although M. Berthollet had dedicated his life to science, yet he had a great taste for literature, and, like his friend Mr Watt, he perused the principal literary works of the day. From his early life he had a great passion for theatrical amusements, which continued to afford him pleasure, even in his latest years. M. Berthollet was a member of most of the scientific institutions

of Europe, who were proud to enrol such a name in the list of their members. We look forward, with high expectations, to the memoir of his life, which may soon be expected from the eloquent pen of Baron Cuvier.

ART. II.—*Account of* Captain HODGSON'S *Journey to the Source of the Jumna, and of the Snow Excavations at Jumnotri, formed by the Steam of Hot Springs* *.

"I SHALL now proceed to give some account of the course of the river *Jumna*, within the mountains, and of its spring at *Jumnotri*, which I also visited this year. In the maps published ten years ago, the *Jumna* is laid down as having a very long course from the latitude of 34½°. It was not known, until the year 1814, that the *Jumna*, properly so called, was a comparatively small river above its junction with the *Tonse* in the *Dún*, and I believe the existence of the latter river, though fully treble the size of the *Jumna*, was unknown to Europeans.

"The junction of the *Tonse* and *Jumna* takes place at the NW. end of the *Dún* valley, in Lat. 30° 30′, where the large river loses its name in that of the small one, and the united stream is called the *Jumna*. The course of the *Jumna* from *Jumnotri*, which is in Lat. 30° 59′, is generally south 50° west. It is fordable above the confluence, but the *Tonse* is not. Not having yet visited the sources of the *Tonse*, I am not certain whether it rises within the *Himálaya*, as the *B'hágirathi* does, or at its SW., or exterior base, like the *Jumna*; but the latter I believe to be the case. I apprehend that three considerable streams, which, like the *Jumna*, originate from the south faces of the *Himálaya*, in the districts of *Barasa*, *Lewiowari*, and *Deodara Kowarra*, join to form the *Tonse*; and it receives a considerable accession of water from the *Paber* river, which I imagine to be equal in size to any of the three abovementioned feeders. Respecting them, I have at present only native information to guide me, but of the *Paber* I can speak with more confidence; for, when in June 1816, I penetrated

---

* Abridged from the *Asiatic Researches*, vol. xiv. p. 128.

within the *Himálaya*, by the course of the *Setlej*, I found that the north bases of many of the snowy peaks, seen from the plains of *Hindustan*, were washed by that river; its course, in the province of *Kunaur*, in Lat. 31° 31′, and Long. 78° 18′, being from east 25 S. to 25 to the N. of west. In this position, the *Setlej* is bounded both to the N. and S. by high and rugged snowy mountains, from which many torrents descend, and increase its bulk. Leaving the left bank, and bed of the river, I ascended the snowy range, of which it washes the north base, and crossed over it on the 21st June 1816, at 40 minutes past 11 o'clock in the forenoon, during a heavy fall of snow, being the first European who effected a passage over the grand *Himálaya* ridge in that direction.

"On surmounting the crest of the pass, I found that the *Indravatí* river, which is a principal branch of the *Pabcr*, originated from the snows, on which I descended, on the SW., or hither side of the ridge; and I followed its channel to the place where it joins the *Pabcr*, which river must have its beginning, in like manner, on the same side of the ridge, as I was informed by the people of the country it had, and I am nearly certain it is the case; and it is most probable, that all the streams which form the *Tonse*, do, in like manner, descend from the south-west side of the fronting snowy range, the north-east base of which is washed by the *Setlej*, as above mentioned.

"The route from the confluence of the *Jumna* with the *Tonse*, in the *Dún*, is thus:—to *Calsí* four miles,—a large village immediately within the mountain of *Jaunsar*, of which district it is esteemed the capital. It is situated between two high and steep mountains, and on the *Omla*, a small river which joins the *Jumna*. *Calsí* is a place of some little trade, as the people of the neighbouring mountains bring to it their productions, and exchange them for cash to pay their rents, and a very small quantity of the produce of the plains. On the march, the *Jumna* is forded above its confluence with the *Tonse*. Carriage cattle may go to *Calsí*, but further within the mountains every article is carried on men's backs. Latitude of *Calsí* 30° 31′ 24″.

"*Calsí to Bairat Fort.*—Total distance 24,511 paces. 6000 paces of exceedingly steep ascent of the mountain, on the left bank

of the *Omla*;—2600 easier, to the village of *Khuny* on the ridge; remainder, along the mountain's side, with occasional ascents and descents, to the foot of the peak of *Birat,* which rises conically above the ridge;—1800 paces of the steep ascent up it to the fort, which is a small double inclosure. It was abandoned by the *Gorc'ha* garrison, on the approach of a force under Colonel Carpenter.

"The height of *Birat* above *Seharanpur*, (which is visible from it), is 6508 feet; it commands a noble view of the snowy mountains, and the various intermediate ranges, as well as of the *Dún* valley, and the plains on both sides of the *Jumna.*

"Invalids from the plains, requiring a change of climate, may find it at *Birat.* In the winter, the fort is almost buried in snow, which remains in shady places, and on the northern side of the peak, till the beginning of April; but snow seldom falls later than the last week of March, at which season, while I was in the fort, there was a shower which covered the ground to the depth of 2 inches: the peak is a bare slaty rock, with some quartz intermixed.

"*29th March* 1817.—*Birat to Murlang.*—Total distance 4 miles 6 furlongs.—2 miles 5 furlongs, narrow path along the mountain's side, then a steep descent of 2 miles 1 furlong to *Murlang*, a small village in a glen, on the *Silgad* rivulet, which falls into the *Jumna*, three miles to the east. No grain here. Lat. observed 30° 36′ 53″. Thermometer at noon 78°. It was yesterday, at noon, at *Birat*, 50°.

"*30th March.*—*Murlang to Cot'ha.*—Total distance 9 miles 5 furlongs. Proceed 2½ miles down the bed of the *Silgad* to the *Jumna*,—then leave it, and cross a ridge, and go up the bed of the *Jumna* to the confluence of the *Cunti* river, which joins it from the *Kenach* peak to the west. That river is about 60 feet wide, and 1½ and 2 feet deep. The *Jumna* is 90 feet wide, 3 to 5 feet deep, rapid, and not fordable. The rest of the path is a long ascent of the mountain, above the right bank of the *Jumna* to *Cat'ha*, a village of ten houses, above 3000 feet above the level of the river. A fatiguing march,—heavy rain. —No grain here.

"*31st March.*—*Cot'ha to Lacka Mandal.*—Total distance 8 miles 7 furlongs.—For 6 miles 7 furlongs, the path lies gene-

rally along the side of the mountain, with occasional strong ascents and descents; 1 mile 5 furlongs of very steep descent into a dell, the rest lighter descent, flat and ascent from a rivulet to *Lak'ha Mandal*, on the right bank of the *Jumna*, and about 300 feet above it.

" *Lak'ha Mandal* is a place of some celebrity, in *Hindu* story, as having been one of the temporary residences of the *Pundus*; and tradition says, that formerly there was a great number of statues and temples here; but I imagine the greater part to have been buried by the slip of the side of the mountain, at the foot of which it is situated. Several pieces of cornices, entablatures, and other ornamental fragments of buildings, are seen projecting above the soil, which buries the remainder; they are of black stone, and the carving of the ornaments is very well executed. There are also two statues of BHIM and ARJUN, of the size of life, which are half buried in the soil; and a prodigious number of small idols are deposited in a little temple, which is the only one now remaining, and which does not appear to be of any remote antiquity. The ignorant *Brahman* could give no account of the builder; he declared, as they all do, when consulted on such subjects, that it is not of human workmanship, but was built by Bhim, countless ages ago.

" It does not appear that pilgrims now resort here; the place is nearly desolate; it is surrounded by high rocky peaks, and may have been chosen as a fit seat for gloomy and recluse superstition.

" Within the temple, there is a large slab of blue stone, inscribed with *Hindu* characters; I cleaned it, and took off a reversed impression, as well as circumstances would allow, and sent it to Colonel Mackenzie. Lat. of *Lak'ha Mandal* 30° 43′ 24."

" *Lak'ha Mandal to Bencauli.*—Distance 3 miles 5 furlongs. Gradual descent 1¼ miles to the *Ricnar* river, which is the boundary between *Sirmor*, and the *Rewaen* district of *Gurhwal.* It has a course of about 10 miles from the NW., and joins the *Jumna* here. From the river, a very strong ascent of 1¼ mile up the mountain, to a crest called *Génda Ghát*; three obliquing to *Bancauli*, a village of twenty houses, with a temple;—it is on the mountain's side, and about 3000 feet above the *Jumna*.

No grain to be had here, as at other places. I planted potatoes. Rainy weather;—no latitude.

3d April 1817.—*Bancaulí to Pauntí.*—Total distance 11 miles 1 furlong by the wheel; in paces 23,108.—To the bed of the *Jumna* 3 miles 3 furlongs, mostly oblique descent, though steep in some places above the right bank of the river. Here are very high and steep precipices, from which large blocks of granite have fallen into the bed of the river, which forces its way through and over those obstructions with much violence and noise. After passing over the rocks by the river side for half a mile, we leave it, and climb the right bank, by an exceeding steep ascent, to the *Tocni Ghát'i*, which overhangs the stream, and is about 1000 feet above it. Hence, descend a mile to the *Camaulda* river; cross it on trunks of trees laid across, a little above its junction with the *Jumna.*

The *Camaulda* is the largest river which the *Jumna* receives above the confluence of the *Tonse;* its course is from N. 10° west, down the *Ráma Serái* district, which is a small valley, and is reported to be in some places a mile wide, but it is now overrun with *jungles*, full of wild beasts. The *Camaulda*, now swollen by the rain, is about 70 feet wide, and 2½ feet deep, and very rapid. Immediately on crossing it, the country up the *Jumna* assumes a more pleasing appearance; the mountains which bound it, though very lofty, do not rise so abruptly, and several small villages are seen on their lower slopes. On the right bank of the river, there is a slip of level ground 300 to 500 yards wide. The summits of the mountains are covered by cedars and other pines, and the snow yet lies on them. Proceed by the river side to *Pauntí*, a village of twenty houses, pleasantly situated about 400 feet above the *Jumna.* The march was long and fatiguing, as it rained the whole way; the loaded people did not arrive till after dark. At this village, I got supplies of grain. The country I have passed through from *Calsí* is nearly deserted, on account of famine, caused by the crops of last year having been destroyed by the hail, in October. Aware of this circumstance, I have brought grain with me from *Calsí*, and subsisted my followers with it. Latitude of *Pauntí* 30° 48′ 08″.

"*5th April* 1817.—*Paunti to Gira.*—Total distance 7 miles 1½ furlong—2¼ miles parallel to the *Jumna*, and descend to its bed, where the stream from the *Banaul* glen joins it. Leave the *Jumna*, and proceed three miles NW. up the *Banaul* river. Then ascend the south face of the mountain to *Gira*, a village of ten large houses pleasantly situated, and sheltered from the northern blasts. This district of *Banaul* is about seven miles in length; the NW. end is closed by a high rocky mountain, where the stream arises which waters the bottom of the glen.—Several villages are seen placed in advantageous situations on the sides of the mountains, the soil of which is fertile; wood, water, and grain are abundant.

"As I learnt that much snow yet remained on my route forward, I halted here some days to give it time to melt, and to refresh my people, who were harassed by the journey from *Calsi*, for it had rained every day, and they had been sparingly and ill fed, and also to take the rates of my chronometers.

"*12th April* 1817.—*Gira to Thánno.*—Total distance 8 miles. Down the N. side of the glen, and pass through the villages of *Bisát* and *Déváli*, to *Dakiát*, a large village, 4 miles 6 furlongs. Proceed parallel to the *Jumna*, but above it 1 mile 6 furlongs, and descend to the *Badál* river, which comes from a glen similar to that of *Banál*, but is longer, and contains more and larger villages.

"The river joins the *Jumna* here; it comes from the *Cedára Cánta*, a large mountain covered with snow, and its course is from N. 15° west; breadth about 40 feet, depth 1½ and 2 feet. Proceed 1½ miles further to *Thánno*, a small village, 400 feet above the right bank of the *Jumna*.

"The road to-day chiefly on a gradual descent; path good and pleasant. The *Jumnotri* snowy peaks, seen up the river, have a noble appearance; the eastern peak bears 56° 17′ NE.;—its altitude 8° 16′. *Thánno* appears to be 4083 feet above the level of *Seharanpur*. Latitude observed 30° 49′ 12″.

"*13th April* 1817.—*Thánno to Catnaur.*—Total distance 4 miles 2 furlongs. Steep descent to the *Jumna*, and cross it on a *sangha*, which consists of three small spars and some twigs bound together, and laid across in the manner of a hurdle.—The *sangha* is in two portions, being laid from rock to rock;

one is nine paces in length, and the other seven, the breadth of the river being about 40 feet; but it is deep, being confined between the rocks, through which it falls like a cataract. The water nearly touches the bridge, which is a bad one. Some of my goats fell through it, and were drowned. Above this place the bed of the *Jumna* is much inclined; the stream bounds from rock to rock, and, for the most part, is a series of small cataracts.

"A mile beyond the *Sangha*, cross the *S'ilba*, a small river from the glen of that name, and proceed to *Catnaur*, a small village 500 feet above the left bank of the *Jumna*: up the *S'ilba* glen is a convenient pass over the ridge which separates the *Ganges* and *Jumna*.

"The path to-day chiefly ascent and descent, and very rough and steep in most places; and hence, forward, the features of the mountains bear a harsher appearance, there being generally mural precipices rising from the bed of the *Jumna* to the height of 1500 to 2000 feet, either on one side or the other. The summits of the mountains all round are deep in snow. A stream from a peak called *Dallia Cursu*, joins the *Jumna* here, from the SE. Latitude observed, 30° 51′ 35″.

"As no grain was to be had here, I was obliged to march, in the afternoon, to a very large village called *Páli*, situate up a wild glen; this was a good deal out of my route. The inhabitants of *Páli*, and the neighbouring villages, have been noted for a rebellious spirit against both the *Gur'hwá* and *Gorc'ha* governments. They had cut off several parties of the *Rája's* troops, and surprised and destroyed a complete company of *Gorc'has*, several years ago, for which they were punished by a force sent against them, under the brave chief *B'hacti T'hápa*. On my arrival, they refused to sell me supplies, and I expected to have had trouble. However, towards evening, we came to a better understanding, and I got abundance of grain. The village consists of about fifty large houses; the inhabitants are stout and hard featured, and the women generally have light complexions, and agreeable countenances. In the morning, I went down the glen 1¼ miles, and then along the right bank of the *Jumna*, but high above it, by a difficult and very unpleasant pathway overhanging it. In one place, I was obliged to go with great cau-

tion, and bare footed, for a false step would be fatal. The precipices on the opposite side of the river are quite perpendicular, and on this, exceedingly steep. After passing the worst part, descend to *Ofha Ghur*, a hamlet of three huts only, in a dismal situation, at the foot of steep and lofty cliffs,—the rocks hurled from which, by the earthquake of 1803, buried a small fort and village, which once stood here:—dreadful mementos are seen in these mountains of the effects of that catastrophe. Under *Ofha Gur*, a stream falls into the *Jumna*, and several cataracts are seen falling among the surrounding precipices. There are some hot springs at the bed of the *Jumna*, which is 400 feet below the hamlet. Latitude observed, 30° 54′ 47″.

" *15th April* 1817.—*Ofha Gur* to *Ráná*.—Total distance 4 miles 5 furlongs.—In paces 91,815. 2655 paces along the mountain's side, and descent to the *Jumna*. Cross it on a sangha of two small spars. Its length 20 feet, breadth about 2½ feet. The river rushes with great violence under the sangha, and nearly touches it. The general breadth of the stream is greater, but it is here confined between two rocks. 1200 paces by the margin of the river; the rest, for the most part, ascent, and, in some places, very steep and rugged.

" *Ráná* is a small village of 15 houses, about 800 feet above the left bank of the river, on the slope of the mountain;—the general lower line of snow on it does not appear to be more than 1000 feet above the village. The opposite bank of the river is composed of yellow granite precipices, rising murally from the stream to the height of about 2500 feet, or more. The courses of the rock are disposed almost horizontally, as high as 1000 feet above the river; but, towards the summits, they appear to incline in an angle of about 35°, the apex being to the south-west. Heavy storms of hail and thunder.

" *16th April* 1817.—*Ráná to Bannása*.—Distance 7839 paces. Ascents and descents to the small village of *Bárí*, 2356 paces; 684 paces further descent to the *Burhá Gangá* river, which has a course of about 8 miles from the snows to the right; it is in two streams, each 8 paces wide, and 18 inches deep, and joins the *Jumna*; 1480 paces of exceedingly steep ascent; the remainder, ascents and descents, and difficult road. Cross the *Jumna* on a sangha, and also the *Bannása* river, which is about

two-thirds of its size, and joins it here. Ascent to *Bannása*, a small village, at the foot of a rocky mountain, a fall from which, last year, destroyed half the village. Angle of altitude of the mountain 40° 55′. Among the cliffs, and on the summit, I observed, with a telescope, many of a species of animal, peculiar to these elevated regions: it is called *Pheir*; and, as a mountaineer in my service succeeded, after many toilsome chaces, in shooting one of them, I can give a description of its dimensions.

	Ft.	In.
Length, from the tip of the nose to end of the tail; the length of the face being 11 inches, and of the tail 3 inches,	5	0
Height from shoulder to toe, - - -	3	2½
Girth at the chest, - - - -	2	11½
Ditto at the loins, - - - -	2	4

Length of the hair at the shoulders 3 inches; but, on the other parts of the body, it is short.

" I preserved the skin and the bones of the head and horns, and presented them to the Most Noble the Governor General, who, I believe, sent them to Sir Joseph Banks.

" The face of the animal, which was a male, resembles that of the *Nil Gao*. The horns are large, the lower part of them stands nearly erect from the forehead, but the upper half bends backward. The hoofs are cloven. The colour is that of a camel or lion, and the long hair about the shoulders and neck somewhat resembles a lion's mane. The flesh appeared coarse, and an unpleasant musky smell exhaled from it. The *Hindustanis* would not touch it, but the *Gorc'ha sipahis*, and mountaineer *Coolies*, ate it with avidity. It is remarkable that those people will not eat mutton. The *Pheir* is a gregarious animal, and appears to subsist on the short herbage at the edge of the snow.—The chace of it, in its haunts on the cliffs and precipices, is most difficult and dangerous; but, in the depth of winter, when the snow drives them down to the villages, the people hunt and kill them more easily.*

" In this neighbourhood, springs of hot water are very numerous; they are seen bubbling up among the rocks in various places near the rivers. The heat of the water is too great to bear the hand in it for many moments; but, having broken my long-scaled thermometer, I could not ascertain its precise temperature. The water has little, if any taste. About half a

mile above its junction with the *Jumna*, the *Bannasu* river falls from a precipice of yellow and rose coloured granite, of 80 or 90 feet high, in a noble cascade. The breadth of the stream is about 15 feet, and it falls into a deep basin, which it has worn in the rock, with much noise.

" This stream is caused by the melting of the snows on the heights above.

" From the village, two of the *Jumnotri* peaks appear towering above the clouds, with sublime effect. Angle of altitude, (taken by reflection in mercury), of the east peak 15° 34′ 45″, of the west 17° 10′ 10″.

" 16th April 1817.—*Bannasa*, situated in Long. 5h 13′ 47″, Lat. 30° 55′ 50″.

" 17th April, 1817.—*Bannasa* to *Cursali*.—Thermometer at sunrise 38°.

" Descend to the *Jumna*, and cross it on a plank 12½ feet long, and again on a plank of 10 feet;—depth of the water 2½ feet. Beds of frozen snow extend to the margin of the stream. A most laborious and steep ascent of 675 paces, whence we gradually descend, and cross the *Jumna* on a small *Sangha*, where it receives the *Imri* rivulet from the snow, whence it originates, about 1½ mile to the end. It is less than the *Jumna*, which is now reduced to the rank of a rivulet. Strong ascent to the river of *Cursali*. Total distance 4978 paces.

" The village of *Cursali* contains about 25 substantial houses, and is situated at the immediate feet of the *Jumnotri* snowy peaks; but they are not visible, as the near and steep part of the base obstructs the view. The situation of *Cursali* is very peculiar, and one will hardly suppose that people should choose to live in such a remote and cold place. It is the latter end of April, and yet, daily slight showers of snow fall, and the remains of drifts yet lie in shaded places in the village. By the sides of the *Imri* and *Jumna*, there are several spots of flat ground, on which the inhabitants cultivate grain enough for their subsistence. To the west, north, and east, this little secluded place is bounded by the lofty cliffs of the *Himalaya*; and to the south, it is sheltered by a mountain, the north face of which is not so steep, and it is clothed with trees. All those are at present deep in snow, which reaches down to the level of the two streams;—

yet I found the place by no means an uncomfortable abode, for the heights near it shelter it from the violence of the winds. The sun is pleasantly warm in the middle of the day, and the progress of vegetation is rapid, in proportion to the length of the winter. The rocky and snowy defile called the *Jumnotri*, where the *Jumna* originates, is seen in the direction of N. 42° east. Distant 3 miles. Latitude of *Cursali* 30° 57′ 19″."

On the 21st April, Captain Hodgson went from Cursali to Jumnotri, a distance of 2 miles 7 furlongs. He ascended, at Bhairo-Ghati, the steepest ascent he ever met with, by cutting steps in the snow with spades. He then descended a steep path, by steps cut in the snow, to the Jumna, where a cascade of the stream cuts through the snow, and falls from a rock about 50 feet high. Excepting where the stream is visible for a few yards, through a hole in the snow, the snow-bed is about 100 yards wide, and bounded by high precipices, from which masses of rock of 40 feet in length have recently fallen.

"At *Jumnotri*, the snow, which covers and conceals the stream, is about 60 yards wide, and is bounded to the right and left by mural precipices of granite; it is 40 feet 5½ inches thick, and has fallen from the precipices above. In front, at the distance of about 500 yards, part of the base of the great *Jumnotri* mountain rises abruptly, cased in snow and ice, and shutting up and totally terminating the head of this defile, in which the *Jumna* originates. I was able to measure the thickness of the bed of snow over the stream very exactly, by means of a plumb line let down through one of the holes in it, which are caused by the steam of a great number of boiling springs which are at the border of the *Jumna*. The snow is very solid, and hard frozen; but we found means to descend through it to the *Jumna*, by an exceedingly steep and narrow dark hole made by the steam, and witnessed a very extraordinary scene, for which I was indebted to the earliness of the season, and the unusual quantity of snow which has fallen this year. When I got footing at the stream, (here only a large pace wide), it was some time before I could discern any thing, on account of the darkness of the place, made more so by the thick steam; but having some white lights with me, I fired them, and, by their glare, was able to see

and admire the curious domes of snow over head; these are caused by the hot steam melting the snow over it. Some of these excavations are very spacious, resembling vaulted roofs of marble; and the snow, as it melts, falls in showers, like heavy rain, to the stream which appears to owe its origin in a great measure to these supplies. Having only a short-scaled thermometer with me, I could not ascertain the precise heat of the spring, but it was too hot to keep the finger in it for more than two seconds, and must be near the boiling point. Rice boiled in it but imperfectly. The range of springs is very extensive, but I could not visit them all, as the rest are in dark recesses and snow caverns. The water of them rises up with great ebullition through crevices of the granite rock, and deposits a ferruginous sediment, of which I collected some. It is tasteless, and I did not perceive any peculiar smell. Hot springs are frequent in the *Himálaya:* perhaps they may be a provision of nature, to ensure a supply of water to the heads of the rivers in the winter season, when the sun can have little or no power of melting the snows in those deep defiles.

" From near this place, the line of the course of the *Jumna* is perceptible downward to near *Lak'ha Mandal*, and is 55° 40′ S.W. From the place called *Bhairo Ghátí*, the bed of the river is overlaid with snow to the depth of from 15 to 40 feet, except at one or two places, where it shews itself through deep holes in the snow.

" The snow bed is bounded to the right and left by mural precipices of light coloured granite. On some ledges there is a sprinkling of soil, where the *B'hojpatra* bushes grow. The end of this dell or defile is closed, as before observed, by part of the base of the great snowy mountain of *Jumnotri*, and which is visible from the plains. The altitude of the part of the mountain, visible, is 29° 48′; but higher parts are concealed by the lower and nearer. The face of the mountain, which is visible to the height of about 4000 feet, is entirely cased in snow and ice, and very steep. The foot of the base is distant from the hot springs about 500 yards, and immediately where the ascent becomes abrupt, a small rill is seen falling from a rock, which projects from the snow. It is about 3 feet wide, and shallow, being only a shower of spray produced by the snow now thawing

in the sun's rays at noon. Above that, no water whatever is seen. If there were any, it would be visible, as the whole steep base of the mountain is exposed to view, directly in front; consequently, the above rill is the most remote source of the *Jumna*. At the present season, it was not possible to go to it, as the snow-bed was further on impassable, being intersected by rents and chasms, caused by the falling in of the snow, as it melts by the steam of the boiling springs below it.

"Here, then, is the head of the *Jumna*, on the S.W. side of the grand *Himálaya* ridge, differing from the *Ganges*, inasmuch as that river has the upper part of its course within the *Himálaya*, flowing to the south of east to the north of west; and it is only from *Suc'hi*, where it pierces through the *Himálaya*, that it assumes a course of about south 20° West."

The fall of the *Jumna*, from *Jumnotri* to the *Dún*, is very considerable. The height of *Jumnotri* above the sea is about 10,483 feet. The latitude of the hot springs is 30° 58′ 52″; and that of the small hill, which is the head of the *Jumna*, is 30° 57′ 6″.

"Having finished my observations by two o'clock, I set out to return. The heat of the sun had then began to melt the snow on the cliffs on both sides, and many rocks and lumps of snow were falling down: this obliged us to run with all speed down the snow-bed, to get out of the way of these missiles. Several of the people had narrow escapes from the falling fragments, but no one was struck.

"The inhabitants of *Cursálí* say, that it is seventeen years since they had so severe a winter as the last.—At *Jumnotri*, the inclination of the granite rock is from 43° to 45° from the horizon. The apex being to the S.W. or towards the plains.

"As the season was not sufficiently advanced to allow of my passing to the *Ganges* by the *Chíá* or *Cílsaum* mountains, both of which are at present impassable from the depth of snow on them, I returned to *Catnaur*, and going up the *Shiálba* glen, crossed the ridge, which divides the two rivers at the *Jackeni Ghát*, and descended by *Bauna*, to *Barahat*, from whence I proceeded up the *Ganges* to *Reital*, and continued my route beyond *Gangotri*, as before mentioned."

Art. III.—*On Petrifactions, or Fossil Organic Remains.* By Baron Alexander Humboldt.

Of the various proofs of the identity of formations in the most distant regions of the globe, one of the most striking, and for which we are indebted to the assistance of zoology, is the identity of the organic bodies contained in strata having a similar geological position. The researches which lead to this kind of proofs, have exercised the skill of the learned, since Messrs De Lamarck and Defrance began to determine the fossil shells of the neighbourhood of Paris, and since Messrs Cuvier and Brongniart published their memorable works on the fossil bones and tertiary formations. As the greater portion of the formations which compose the crust of our planet contain no organic remains, and as these remains are of very rare occurrence in the transition formations, and are often broken and difficult to detach from the rock in the older secondary formations, the study of fossil organic bodies comprehends but a small part of geognosy,—a part, however, very worthy of the attention of the philosopher. The problems which present themselves in this department, are numerous: They bear relation to the geography of animals, whose races are extinct, and which, for this reason, already belong to the history of our planet: They render necessary the discussion of the zoological characters, by which we would distinguish the different formations. To remain faithful to the plan which I have proposed to myself, of only considering the various objects in the most general way, I shall now mention those questions of *Geognostical Zoology*, which appear the most important in the present state of science, and whose solution has been tried with more or less success. What are the Genera, and (if the state of preservation and degree of attachment to the rock permit a more complete determination) what are the Species, to which the fossil remains may be referred? Does an exact determination of the species discover any which are identical with the plants and animals of the present world? What are the classes, the orders, and families of organized beings, which present the greatest number of these analogies? In what proportion does the number of identical genera and species increase, with the newness of rocks or of earthy deposits? Is the

order observed in the superposition of transition, secondary, tertiary, and alluvial formations, every where in harmony with the increasing analogy which the types of organization present? Do these types succeed each other from below upwards, passing from the grey-wackes and black transition limestone, through the coal sandstone, Alpine limestone, Jura limestone, chalk, the tertiary gypsum, to the fresh water and modern alluvial formations, in the same order which we have adopted in our systems of natural history, by arranging animals according as their structure becomes more complicated, and as other systems of organs are added to those of nutrition? Does the distribution of fossil organic bodies indicate a progressive development of vegetable and animal life upon the globe,—a successive appearance of acotyledonous and monocotyledonous plants, of zoophytes, crustacea, mollusca; (cephalopoda, acephala, gasteropoda), of fishes; oviparous quadrupeds; of dicotyledonous plants; of marine mammifera and of terrestrial mammifera? Considering fossil organic bodies, not in their relation with such or such a rock in which they have been discovered, but simply with regard to their climacteric distribution, is an appreciable difference to be observed between the species which predominate in the old and in the new continent, in the temperate climates, and under the torrid zone, in the northern and in the southern hemisphere? Is there a certain number of tropical species which are found every where, and which seem to announce, that, independently of a distribution of climates similar to the present, they have experienced, in the first age of the world, the high temperature which the cracked crust of the globe, strongly heated in its interior, had given to the ambient atmosphere? Can the fresh-water shells be distinguished with certainty, by means of precise characters, from those of marine origin? Is the determination of the genus sufficient for this purpose, or are there not (as among fishes) certain genera, the species of which live both in the sea and in rivers? Although, in some of the tertiary rocks, the fluviatile shells occur mixed (for example, at the mouths of our rivers) with the pelagic shells, do we not observe, that the first form particular deposits, characterizing formations, the examination of which has been hitherto neglected, and which are of very recent origin? Have fresh-water shells ever been discovered under the Jura

limestone, among reputed fluviatile fishes, in the bituminous slate of the Alpine limestone? Do identical species of petrifactions or fossils occur in the same formations in different points of the globe? Are they capable of furnishing zoological characters for distinguishing the different formations? Or, should it not rather be admitted, that species which the zoologist is entitled to consider as identical, following the methods usually adopted, penetrate across several formations; that they are even seen in those which are not in immediate contact? Should not the zoological characters be taken both from the total absence of certain species, and from their relative frequency or *predominance*, as well as from their constant association with a certain number of other species? Is it right to divide a formation, whose unity has been determined from relations of position, and from the identity of the beds, which are equally interposed between upper and lower strata, merely because the first of these strata contain fresh-water shells, while the last contain marine ones? Is the total absence of organic bodies in certain masses of secondary and tertiary formations, a sufficient reason for considering these masses as particular formations, if other geognostical relations do not justify this separation?

Some of these problems engaged the attention of geologists at an early period. Lister had already maintained, upwards of 150 years ago, that each rock was characterized by different fossil shells,—(*Philosophical Trans.*, No. 76, p. 2283.) With the view of proving that the shells of our seas and lakes are specifically different from fossil shells (*lapides sui generis*), he affirms, "that the latter, for example, those of the Northamptonshire quarries, have all the characters of our *murices*, *tellinæ*, and *trochi*; but that naturalists, who are not accustomed to content themselves with a vague and general perception of things, will find the fossil shells *specifically* different from those of the present world." Nearly at the same period, Nicolas Stenon, (*De solido intra solidum contento*, 1669, p. 2, 17, 28, 63, 69, fig. 20, 25,) first distinguished "the (primitive) rocks anterior to the existence of plants and animals upon the globe, and consequently never containing organic remains, and the (secondary) rocks superimposed upon the first, and abounding with these remains (*turbidi maris sedimenta sibi invicem imposita*)."

He considered each bed of secondary rock "as a sediment deposited by an aqueous fluid;" and, exposing a system perfectly similar to that of Deluc, "On the formation of valleys by longitudinal sinkings, and on the inclination of beds originally all horizontal," he admits, with regard to Tuscany, in the manner of our modern geologists, "six great epochs of nature (*sex distinctæ Etruriæ facies, ex præsente facie Etruriæ collectæ*), according as the sea periodically inundated the continent, or retired within its ancient limits." In those times, when the observation of nature gave rise in Italy to the first ideas regarding the relative age and succession of the primitive and secondary strata, zoology and geognosy could not yet be of mutual assistance, because the zoologists of those days were not acquainted with the rocks, and the geognosts were entirely strangers to the natural history of animals. Naturalists confined themselves to vague perceptions; they regarded as specifically identical all that presented any analogy of form; but, at the same time, and this was a step made in the true road, they were attentive to the fossils found in such or such rocks. Hence the denominations *limestone with gryphites, limestone with trochites, slates with ferns,* and *slates with trilobites,* (Gryphiten und Trochiten-Kalk, Kräuter und Trilobiten-Schiefer), were long ago employed by the mineralogists of Germany. The determination of genera whose characters are derived from the teeth, and other parts of the hinge, and from the opening of the shell, is much more difficult in the oldest secondary rocks than in the tertiary formations, the former being in general harder, and adhering more closely to the body of the shell. This difficulty increases, when it is attempted to distinguish the species; it becomes almost insurmountable in some limestone-rocks of the Transition class, and in the shell-limestone or muschelkalk, which contains broken shells. Could the zoological characters of a certain number of formations be taken from very distinct genera, and did the trilobites and orthoceratites belong exclusively to the transition formations, the gryphites to the alpine limestone (zechstein), the pectinites to the variegated sandstone or *bunter* sandstone (grès de Nebra), the trochites and mytilites to the shell-limestone (muschelkalk), the tellinæ to the quader-sandstein, the ammonites and turritellæ to the Jura limestone

and its marls, the ananchytes and spatangi to the chalk, the cerithia to the coarse limestone; the knowledge of these genera would prove an easy and effectual aid in the determination of rocks: it would no longer be requisite to examine the superposition of formations on the spot, for they could be distinguished without stirring from one's cabinet, by the mere examination of specimens. But it is far from being the case that nature has rendered the study of the shelly masses which compose the crust of the earth so easy to man. The same types of organization are repeated at very different epochs. The same genera occur in different formations. There are orthoceratites in the transition-limestones, the Alpine limestones, and the variegated sandstone; terebratulites in the Jura limestone and shell-limestone (muschelkalk); trilobites in the transition clay-slates (thonschiefer), in the bituminous marl-slate, and, according to an excellent geognost, M. de Schlottheim, even in the Jura limestone. There are pentacrinites in the transition clay-slate and the newest shell-limestone (muschelkalk). The ammonites penetrate across many of the limestone and marl formations, from the greywackes to the lower beds of the chalk. Trunks of monocotyledonous plants are found both in the red sandstone and in the marls of the fresh-water gypsum, formed at a period when the world was already filled with monocotyledonous vegetables.

But at a period when naturalists are no longer satisfied with vague and uncertain notions, it has been discovered that the greater number of those petrifactions or fossils (gryphites, terebratulites, ammonites, trilobites, &c.) imbedded in different formations, are not specifically the same; and that a great number of species which have been determined with precision, vary with the superimposed rocks. The fishes which are observed in the transition-slates (Glaris), in the zechstein or bituminous marl-slate, in the Jura limestone, in the tertiary limestone with cerithia of Paris and Monte Bolca, and in the gypsum of Montmartre, are distinct species, partly pelagic and partly fluviatile. Might it be concluded, from these facts, that all the formations are characterised by particular species; that the fossil-shells of the chalk, of the shell-limestone (muschelkalk), of the Jura limestone, and of the alpine limestone, are all different from

each other? I am of opinion that this would be pushing the induction too far; and even M. Brongniart, who was so well acquainted with the value of zoological characters, has limited their absolute application to cases where the superposition (the circumstances of relative situation) do not oppose it. I might mention the cerithia of the coarse limestone, which occur (near Caen) beneath the chalk, and which seem, like the repetition of the clays with lignites above and below the chalk, to shew a certain connection between formations which at first sight might be considered entirely distinct. I might adduce other species of shells, which belong at once to several tertiary formations, and observe, that should species, which at the present day are believed to be identical, be separated at some future time by means of characters not readily observable, and by slight shades of difference, even the delicacy of these distinctions would not prove too great an inducement to believe in the universality, otherwise so desirable, of zoological characters in geognosy. Another objection, taken from the influence exercised by climate even upon the pelagic animals, appears to me more important still. Although the seas, from well-known physical causes, present at great depths the same temperature under the equator and in the temperate zone, we find, however, that, in the present state of our planet, the shells of the Tropics (among which the univalves predominate, as among the fossil testacea) differ much from those of the temperate climates. The greater number of these animals live upon reefs and shoals; whence it follows that the specific differences are often very sensible, under the same parallel, on opposite coasts. Now, were the same formations repeated and extended, so to speak, to prodigious distances, from east to west, and from north to south, from one hemisphere to the other, is it not probable, whatever may have been the complicated causes of the ancient temperature of our globe, that variations of climate have modified, in ancient times as at the present, the types of organisation, and that one and the same formation (that is to say, a rock of the same nature placed, in the two hemispheres, between homogeneous formations) may have enveloped distinct species? It no doubt often happens, that superimposed beds present a very striking contrast of fossil bodies; but should it be concluded from this, that, after a deposit was

formed, the beings which then inhabited the surface of the globe were all destroyed?

It is incontestible, that generations of different types have succeeded one another. The ammonites, which scarcely occur among the transition rocks, attain their *maximum* in the strata which on different points of the globe represent the shell-limestone (muschelkalk) and Jura limestone; they disappear in the upper beds of the chalk, and above this formation. The echinites, which are very rare in the alpine limestone, and even in the shell-limestone (muschelkalk), become, on the contrary, very common in the Jura limestone, in the chalk and the tertiary formations. But nothing proves to us that this succession of different organic types, this gradual destruction of genera and of species, necessarily coincides with the periods when each formation was deposited. "The consideration of similarity, or of discrepancy between organic remains, is not of great importance," says M. Beudant (*Voyages Min.* v. iii. p. 278.), "when we compare deposits formed in countries very remote from each other; but it is of much importance, when we compare those which are very near."

In combating the two absolute conclusions which might be attempted to be derived from the validity of zoological characters, I am far from denying the important services which the study of fossil bodies renders to geognosy, if we consider this science under a philosophical point of view. Geognosy does not limit itself to the searching for diagnostical characters; it embraces the aggregate of relations under which each formation may be considered: 1*st*, Its relative position; 2*dly*, Its oryctognostic constitution (that is to say, its chemical composition, and the particular mode of aggregation, more or less crystalline, of its molecules); 3*dly*, The association of different organic bodies which occur imbedded in it. If the superposition of heterogeneous rocky masses reveals to us the successive order of their formation, is it not also interesting to know the state of organic nature at the different periods when these deposits were formed? Can it be questioned, that, over a surface of many thousands of square leagues (in Thuringia, and in all the northern part of Germany), nine superimposed formations, those, namely, of the transition limestone, greywacke, red sandstone,

zechstein with bituminous marl-slate, (muriatiferous gypsum,) oolitic sandstone, (argillaceous gypsum,) shell limestone or muschelkalk, and white sandstone (quadersandstein), have been recognised as distinct, without having any recourse to geological characters; but it does not follow from thence, that the most minute investigation of these characters, or, to speak more correctly, the most intimate knowledge of the petrifactions or fossils contained in each of the formations, is not indispensable for presenting a complete and truly geognostical picture. It is with the study of formations as with that of organic beings. Botany and zoology, which are now considered under a higher point of view, are no longer confined to the investigation of some external characters distinctive of the species; these sciences investigate the whole of vegetable and animal organization. The characters taken from the forms of the shell, suffice to distinguish the different species of acephalous testacea; but, for all this, could the knowledge of the animals which inhabit these shells be regarded as superfluous? Such is the connexion of phenomena, and of their natural relations, that, if some be neglected, there is produced not only an incomplete image, but also a false one.

In the case of the conformity of position, there may be identity of mass (that is to say, of mineralogical composition) and diversity of petrifactions, or diversity of mass and identity of petrifactions. The rocks β and β', placed at great horizontal distances, between two identical formations α and γ, either belong to the same formation, or are of parallel formations. In the former case, their mineral composition is similar; but, from the distance of the places, and the effects of climate, the organic remains which they contain may differ considerably. In the other case, the mineralogical composition is different, but the organic remains may be analogous. I am of opinion that the words *identical formations, parallel formations*, vindicate the conformity or non-conformity of mineralogical composition; but that they determine nothing with regard to the identity of petrifactions. If it is pretty probable that the deposits β and β', placed at great horizontal distances between the same rocks α and γ, have been formed *at the same period*, because they contain the same fossils, and an analogous mass; it is not equally probable, on the other hand, that when the fossils are distinct, the periods

of formation have been very remote from each other. We may conceive that, under the same zone, in a country of but little extent, generations of animals have succeeded each other, and have characterised, as by particular types, the *periods* of formation; but, at great horizontal distances, beings of very different forms, may, in different climates, have simultaneously occupied the surface of the globe, or the basin of the ocean. Further still, the position of β, between α and γ, proves that the formation of β is anterior to that of γ, and posterior to that of α; but nothing gives us the precise measure of the interval between the epochal limits, and different isolated deposits of β cannot be simultaneous.

There seems to result from the facts which the zeal and sagacity of naturalists have united within these few years, that, if we should not always expect to find, as Lister pretended, in each different formation different organic remains, yet that most commonly formations which are shewn to be distinct by their relative situation and composition, contain in the most remote countries of the globe associations of entirely similar species. M. Brongniart, whose labours, together with those of other celebrated mineralogists, have so much advanced the study of *subterranean conchology*, has lately made known the striking analogies which certain formations of Europe and of North America present with regard to fossil organic bodies. He has endeavoured to prove that a formation is sometimes so disguised, that it is only by its zoological characters that it can be recognised, (Brongniart, *Hist. Nat. des Crust. Fossiles*, p. 57, 62). In the study of formations, as in all the descriptive physical sciences, it is the assemblage of many characters which should alone guide us in our search after truth. The specific description of the remains of plants and animals contained in the different formations, presents us, so to speak, their *Flora* or *Fauna*. Now, in the primordial, as in the present world, the vegetation and the animal productions of different portions of the globe, appear to have been less characterised by some isolated forms of an extraordinary aspect, than by the association of many forms specifically different, but analogous to each other, notwithstanding the distance of the places. On discovering a new land near Torres Straits, it would not be easy to determine, from a small

number of productions, whether this land were contiguous to New Holland, or to one of the Molucca Islands, or to New Guinea. To compare formations with relation to petrifactions, is to compare *Floras* and *Faunas* of different countries and of different epochs; it is to resolve a problem so much the more complicated, that it is modified at the same time by space and by time.

Among the zoological characters applied to geognosy, the absence of certain fossils often afford a better characteristic than their presence. This applies particularly to the transition rocks; in general there only occur in them, madrepores, encrinites, trilobites, orthoceratites, and shells of the family of terebratules, that is to say shells of which some species, not identical but analogous, are met with in very modern secondary beds; but these transition rocks, are destitute of many other organic remains, which appear abundantly above the red sandstone. The judgment which we form regarding the absence of certain species, or the total absence of fossil organic bodies, may, however, be founded upon an error which it will be of importance to explain here. On examining the formations which contain imbedded shells in a general manner, we observe that the organic bodies are not always equally distributed in the mass; but, 1*st*, That strata entirely destitute of shells alternate with others which are provided with them; 2*dly*, That, in the same formation, particular associations of fossils characterize certain strata, which alternate with other strata having distinct fossils. This phenomenon, which has been long since observed, occurs in the shell limestone (muschelkalk,) and in the alpine limestone (zechstein), which are often separated by a bed of trochites from the coal sandstone, (Buch, Beob. v. i. p. 135, 146, 171); it is found also in the Jura limestone, and in several tertiary formations. On examining the chalk of the neighbourhood of Paris only, it might almost be thought that the univalve shells are entirely awanting in this formation. The polythalamous univalves, however, the ammonites, as we have already mentioned, are very common in England, in the oldest beds of the chalk. Even in France, (coast of St Catherine near Caen), the tufaceous and chloritic chalk, contains many fossils which are not met with in the white chalk. (Brongniart, Caractères Zool. p. 12.)

As in different countries the formations are not equally developed, and shreds of formations may be taken for complete and entire ones, those which are destitute of shells in one region may present them in another. This consideration is important in obviating the pretty general tendency of multiplying formations in too great a degree; for when, in a particular point of the globe, a formation (sandstone for example) abounds in its lower part with petrifactions, while its upper part is entirely destitute of them, this absence of petrifactions or fossils does not of itself justify the splitting of the deposit into two distinct formations. In the geological description of the neighbourhood of Paris, M. Brongniart has very properly united the millstones without shells, with those which are in a manner studded with fresh-water shells.

We have seen that a formation may contain in different strata, petrifactions specifically different, but that most commonly some species of the lower stratum mingle with the great mass of heterogeneous species which occur united in the superimposed stratum. When this difference relates to genera, of which some are pelagic and others fresh-water shells, the problem of the unity or indivisibility of a formation becomes still more puzzling. Two cases must first be distinguished, that in which some fluviatile shells occur, mixed with a great mass of marine shells, and that where marine and fluviatile shells may alternate bed by bed. Messrs Gilet de Laumont and Beudant, have made interesting observations regarding the admixture of marine and fresh-water productions, in one and the same bed. M. Beudant has proved, by ingenious experiments, how many of the fluviatile mollusca gradually habituate themselves to live in a fluid which has all the saltness of the ocean. The same geologist has, together with M. Marcel de Serres, examined certain species of paludinæ, which, preferring brackish waters, are found near our coasts, sometimes with pelagic shells, sometimes with fluviatile ones. (*Journ. de Phys.* t. lxxxiii. p. 137; t. lxxxviii. p. 211; Brongniart, *Geogr. Min.* p. 27, 54, 89.) To these curious facts are joined others, which I have published in the account of my *Journey to the Equatorial Regions*, (v. i. p. 535, and v. ii. p. 606), and which seem to explain what has formerly taken place upon the globe, according to what we still see taking place

at the present day. On the coast of Terra Firma, between Cumana and Nueva Barcelona, I have seen crocodiles advance far into the sea. Pigafetta has made the same observation regarding the crocodiles of Borneo. To the south of the Island of Cuba, in the Gulph of Xagua, there are lamantines in the sea, at a point where springs of fresh water issue in the midst of the salt water. When we reflect upon these facts, we become less surprised at the mixture of some terrestrial productions with many others indisputably marine. The second case which we have adverted to, that of alternation, is never present, I believe, in a manner so distinct as the alternation of clay-slate and of black limestone, in the same transition formation, or (to adduce a fact relative to the distribution of organic bodies) as the alternation of two great marine formations, (limestone with cerithia, and the sandstone of Romainville), with two great fresh-water formations, (gypsum and millstone of the plain of Montmorency). The result of an attentive examination of the superpositions is merely this; that there are alternating beds of gypsum and marl placed between two marine formations, and containing at the centre (in their largest mass), terrestrial and fresh-water productions, and towards the upper and inferior limits, as well in the gypsum as in the marls, marine productions. Such is the geological constitution of the gypsum of Montmartre. The specific variation in the petrifactions, the mixture observed at Pierrelaie, and the phenomenon of alternation which Montmartre presents, are not sufficient to justify the division of the same formation into fragments. The marls and gypsum which contain marine shells, (No. 26. of the third mass), cannot be geognostically separated from the marls and gypsums which contain fresh-water productions. Nor have Messrs Cuvier and Brongniart hesitated to consider the general mass of these marine and fresh-water marls and gypsums as of one and the same formation. These geologists have even cited this union of alternating beds as one of the clearest examples of what the word *formation* should be intended to express. (*Geogr. Miner.*, p. 31, 89, 189). In fact, different systems of beds may be contained in the same formation: they are groups, subdivisions, or as the geognosts of the Freyberg School express it,

members more or less developed of the same formation." (Freiesleben, *Kupf.* v. i. p. 17. v. iii. p. 1).

Notwithstanding the mixture of pelagic and fluviatile shells which is sometimes observed at the point of contact of two formations of different origin, the name of *Marine Limestone*, or of *Marine Sandstone*, may be given to the one of these formations, when the denomination of the rocks could only be taken from the species which constitute the greatest mass and the centre of the beds. This terminology recalls a fact which bears relation, so to speak, to geogony, to the ancient history of our planet; it fixes (and perhaps a little too much) the alternation of the fresh and of the salt waters. I do not dispute the utility of the denominations *marine limestone*, or *marine sandstone*, with regard to local descriptions; but, according to the principles which I have proposed to follow, in the general classification of formations, characterized, according to the place which they occupy, as terms of a series, I have deemed it necessary to avoid them with care. Are all the formations beneath the chalk, or even beneath the limestone, with cerithia (coarse limestone of the basin of Paris), without exception, *marine limestones* and *sandstones*? or do the monitors and fishes of the bituminous copper-slate in the alpine limestone of Thuringia; the ichthyosauri of Mr Home, placed beneath the Oxford and Bath oolites, in the lias of England, (which, on the Continent, is represented by a part of the Jura limestone); the crocodiles of Honfleur, contained in clays, with limestone-beds above the oolites of Dive and Isigny limestone, and consequently superior to the Jura limestone,—do all these prove, that there are already beneath the chalk, between that formation and the red sandstone, small fresh-water formations superadded to the great *marine formations*? Do not the coals containing ferns, situated beneath the red-sandstone and beneath the secondary porphyry, present an evident example of a very ancient formation, not of marine origin? These circumstances show the necessity of much caution in the present state of science, when, from characters purely zoological, it is attempted to divide formations, whose unity has appeared confirmed by the alternation of the same beds, and by other phenomena of relative position. (Engelhard und Raumer, *Geogn. Vers.* p. 125.-132.) This caution is so much the more necessary, that, according to the testimony of a mine-

ralogist who has long attended to this matter, M. Brongniart, "there exists a kind of transition between the marine limestone, and the fresh water gypsum which follows this limestone; and that these two formations do not present, in an abrupt manner, the separation which is seen, in the same places, between the chalk and coarse limestone; that is to say, between two marine formations. It cannot be doubted," adds the same observer, "that the first beds of gypsum have been deposited in a liquid analogous to the sea, while the following ones have been deposited in a liquid analogous to fresh water." (*Geogr. Min.*, p. 168. and 193.)

In announcing the motives which prevent me from generalizing a terminology founded upon the contrast between fresh-water productions and marine ones, I am far from disputing the existence of a fresh-water formation, superior to all the other tertiary formations, and which contains only bulimæ, limneæ, cyclostomata and potamides. Recent observations have demonstrated, that this formation is more general than was at first believed. It is a new and last term to add to the geognostical series. We are indebted for the knowledge of this fresh-water limestone, to the useful labours of M. Brongniart. The phenomena which the fresh-water formations present, whose existence was formerly known only by the tufas of Thuringia, and by the Travertine of the plains of Rome, (Reuss, *Geogn.* v. ii. p. 642.; Buch, *Geog. Beob.* v. ii. p. 21.–30.), are conformable, in the most satisfying manner, to the admirable laws discovered by M. Cuvier, in the position of the bones of viviparous quadrupeds. (Brongniart, *Annales du Museum*, vol. xv p. 357.–581.; Cuvier, *Rech. sur les Ossemens fossiles*, vol. i. p. 54.

The distinction between fluviatile and marine shells is the object of very delicate inquiries; for it may happen, when the remains of organic bodies are, with difficulty, detached from the siliceous limestone in which they are contained, that ampullariæ may be confounded with naticæ, potamides with cerithia, and so forth. In the family of Conchæ, the cyclades and cyrenæ, the venuses and lucinæ, cannot be separated with certainty, but by the examination of the teeth of the hinge. The work which M. de Ferussac has undertaken, on the terrestrial and fluviatile shells,

will throw much light on this important subject. Besides, when a genus of pelagic shells is supposed to be seen in the midst of a genus of fresh water ones, it may be asked, if, in fact, the same generic types might not occur in the lakes and in the seas. We are already acquainted with the example of a true fluviatile mytilus. Perhaps the ampullariæ and corbulæ, may be found to present analogous mixtures of marine forms and of fresh-water ones (See a Memoir of *M. Valenciennes*, inserted in my *Recueil d'Obs. de Zoologie et d'Anatomie comparée*, v. ii. p. 218).

It results from these general considerations regarding the zoological characters and examination of fossil bodies, that, notwithstanding the beautiful and old works of Camper, of Blumenbach and Sömmering, the exact specific determination of species, and the examination of their relations with very modern beds, was only commenced about twenty years ago. I am of opinion, that this examination of fossil bodies applied to all the other secondary and transition strata by geognosts, who, at the same time, consult the relative situation and mineral composition of rocks, far from overturning the system of formations already established, would rather serve to confirm it, to perfect it, and to complete the vast picture which it presents. The geognostical knowledge of formations may, without doubt, be considered under very different points of views, according as the preference is given to the superposition of mineral masses, to their composition (that is to say, their chemical and mechanical analysis), or to the fossils which are found contained in many of those masses. The denominations, *geognosy of situation*, or *of superposition*, *oryctognostic geognosy* (analysing the texture of masses), *geognosy of fossils*, designate, I shall not say branches of one and the same science, but different classes of relations which are attempted to be isolated for their more particular examination. *This unity of the science, and the vast field which it comprehends, were well known to Werner, the creator of positive geognosy.* Although he did not possess the necessary means for giving himself up to a rigorous determination of fossil species, he did not cease, in his lectures, to fix the attention of his pupils upon the relations which exist between certain petrifactions and the formations of different ages. I have been witness of the

lively satisfaction which he experienced, when, in 1792, M. de Schlottheim, one of the most distinguished geognosts of the Freyberg School, began to make these relations the principal object of his investigation. Positive geognosy enriches itself with all the discoveries which have been made regarding the mineral constitution of the globe; it contributes the most precious materials to another science, improperly called *Theory of the Earth;* and which embraces the first history of the catastrophes of our planet. It reflects more light upon this science than it receives from it in return; and, without calling in question the ancient fluidity or softening of all the rocky beds (a phenomenon which is manifested by fossil organic remains, by the crystalline aspect of the masses, and by the rolled pebbles or fragments imbedded in the transition and secondary rocks), positive geognosy does not pronounce on the nature of those liquids in which the deposits are alleged to have been formed, on those *waters of granite, porphyry and gypsum,* which, according to hypothetical geology, have successively covered the same points of the globe *.

Art. IV. *On certain Electrical Phenomena observed at Sea, with an account of the Fire of St Elmo.*

Of all the dangers to which the seaman's life is incident, there is none so fearfully sublime, when viewed at a certain distance, or so dreadfully appalling, when under the impulse of immediate contact, as that combination of meteorological and electrical phenomena, known under the common name of "thunder and lightning." In the dark midnight of an autumnal cruise, as repeated through a series of years upon the southern shores of France, by the unremitting perseverance of the British Fleet, these various sensations have been experienced by thousands. In the midst of a numerous fleet of "Britain's best bulwarks," exposed on such a night to sudden squalls and baffling shifts of wind, when the uncertain drops of rain fall few, but heavy on the deck,—when the ship, at times unmanageable, rolls in the trough of the agitated sea,—when the distant thun-

* Translated from Humboldt's "Essai Geognostique sur le Gisement des Roches dans les deux hemispheres." 8vo, Paris, 1823.

der is heard pealing from off the land, and the vivid lightning discloses at every flash, the scattered fleet,—in circumstances such as these is beautifully exemplified the orderly and determined resolution of the British seaman, whose precarious safety not only deserves, but claims, in the strongest terms, the ingenuity of experimental philosophy in his behalf.

Having thus briefly hinted at the extent of danger to which a man-of-war is liable, from the dreadful effects of the electric fluid, the mind is naturally roused to the contemplation of such plans or devices, as may tend in any way to counteract or prevent the repetition of such calamitous occurrences. The only one, as far as is consistent with my personal experience, that has ever been adopted in the Navy, is that of leading a metallic chain of thin short bars, as a conductor, pointed upwards at the track, and down by the back-stays to the water's-edge; and every large ship is either fitted with one of these, or may be supplied upon application.

This apparatus is, of course, attached to the maintop-gallant-mast-head, as being the most lofty; but it does not always follow, that the lightning is to strike in that direction, having once had the dreadful opportunity of witnessing, with my eyes fixed upon them at the moment, not less than fifteen most valuable men, all upon the bowsprit and jib-boom, killed or dreadfully scorched, as it were, in the "twinkling of an eye." Some were precipitated into the water, and others, lying dead across the boom, continued in the posture they had assumed before the accident took place. This happened on board a 74 at Port Mahon, at a time when all her yards were manned, in the operation of furling sails.

It does not accord with my recollection, whether her conductor was in use or not; but if any real dependence is to be placed on such a contrivance, it appears probable that *one* only is insufficient.

There are, however, opposite opinions as to the merit of this apparatus, as well also as to the propriety of its being used at all; and I do not remember, in spite of repeated accidents, that either the Board of Admiralty, or those great seamen and commanders of the Mediterranean fleet, Lords Nelson, Collingwood and Exmouth, ever did enforce any general regulation on the subject.

A conductor at the maintop-gallant-mast-head, can only be looked upon as an agent more powerful than the mast itself, but by no means calculated positively to draw within its own influence, every portion of electric matter, which may have come first in contact, or in near appulse with any other point; and although the mast-head is almost invariably the first to suffer, yet it is within my own knowledge, though I was not actually present, that several men, in the act of withdrawing their washed clothes from the *main rigging*, were killed and scorched by the descent of the electric fluid.

It would be not only curious, but useful to ascertain, if possible, the following circumstances. 1. How many ships have been struck with lightning, out of a given number in a given time? 2. What has been the loss of lives, the extent of damage, and the *expence of repairs?* 3. How many of these ships were habitually in the practice of using conductors; and, 4. Did any of the ships, having them then in use, suffer from the effects of lightning, and in what manner? It is possible that some of your intelligent readers, whose central situation or official duties, afford the best opportunities of acquiring information, may have it in their power to render some illustration, replete with the deepest interest, and the most beneficial results.

Among those who disapprove, or who are at least doubtful as to the expediency of adopting the ordinary metallic chain, I have no hesitation of being enrolled. The contact of electric fluid, under any circumstances, ought carefully to be avoided; and no single conductor on board of a ship, with her top-gallant-yards across, can positively regulate or restrain the devious course it usually assumes. A ship in that situation, presents at least twenty-four distinct points between the jib and driver-boom ends, all more or less capable of exerting the power of attraction, and liable thereby to occasion a loss of lives; neither does it follow, that the lightning is positively to fall on any one of those points in preference to another, in spite of the precaution of placing conductors at particular points for that particular purpose.

In the month of July 1811, being then on board H. M. S. Kent of 74 guns, off Toulon, the main and mizen masts were shattered by lightning, from the truck downwards. Furling the maintop-gallant sails, the fluid deviating partially, killed one

man, and scorched three or four others then upon the yard. Had there been a conductor up at that time, the chance is, that these brave men might have been saved; but it does not actually follow that the mizen mast would have been equally secure.

Granting, then, the utility of a "chance," we have a right to conclude, that the lives of those aloft, or out upon the boom, and even the masts and boom themselves, are still but insecure, without a conductor being attached at each, which would comprise in all an additional quantity of gear, not reconcileable to the trim and gallant order of a British man-of-war.

The electric matter in the atmosphere, must either be in a quiescent or an active state. When the clouds become surcharged and attract one another, the conductor might possibly be of use. But, again, if we consider, as frequently occurs, the atmosphere and the clouds charged heavily with matter, though still quiescent, could not the presence of such a conductor at such a time, operate in exciting a burst of electricity, pregnant with every danger, which would not have happened, without the presence of such conductor itself, such conductor being a far more powerful agent than the mast, and not altogether capable of controlling the danger arising from the action of itself? The pointed mast is certainly always liable to influence, or attract the quiescent matter with all its force, but much more so is the conductor. Where, then, can be the great propriety of using an apparatus of doubtful tendency, which, though in some instances capable of fortuitous benefit, is, at others, liable to occasion incalculable distress? There are instances, no doubt, of the fluid being carried by the conductor most successfully to the water's edge; but there is also another chance to the contrary, as well as a great probability, that many descents of the electric fluid, either with or without damage, would never actually have occurred, had it not been for the presence of this more powerful apparatus. Whenever it can be fully proved, that accidents never have, nor never can take place, under the use of one or more conductors, whether they have been the means of exciting the electricity from the quiescent state or not, then, and not till then, can their undoubted utility be satisfactorily demonstrated.

In the instance before mentioned, when the fluid fell with

such violence on the jib-boom, some thunder and lightning had previously been seen at a distance. At the ship all was calm, but dark and threatening. Without the accompaniment of thunder, the fire darted, as it were, not from a cloud, but from the immediate atmosphere itself, charged heavily with matter, and called into activity by the presence and contiguity of the ship. Had there been a conductor aloft, it is possible that the descent would have been redoubled; or, had there been no ship at all, nor the presence of any such attractive power, it is probable that the lightning would never have occurred.

Independent of the common electric fluid, the atmosphere appears sometimes to be impregnated with another description of luminous electric meteor, which has been known to be attracted, and settle quickly at the ship's mast-head, without producing any of those dire occurrences before alluded to. This particular appearance has been denominated by foreign seamen *Saint Elmo's Light*, a beautiful instance of which I had once an opportunity of witnessing.

In the month of June 1808, passing from the Island of Ivica to that of Majorca, on board a Spanish polacca ship, fitted as a cartel, and manned by about thirty ruffians, Genoese, Valencians, and Catalonians; a fine southerly gale, by seven in the evening, brought us within 6 or 7 leagues of the anchorage in Palma Bay. About this time, the sea-breeze failing us astern, was shortly succeeded by light and baffling breezes off the land. No sooner had the setting sun withdrawn his golden beams from the tops of the lofty hills, which rise to the westward of the town, than a thick and impenetrable cloud, gathering upon the summit of Mount Galatzo, spread gradual darkness on the hills below, and extended at length a premature obscurity along the very surface of the shore. About nine, the ship becalmed, the darkness was intense, and rendered still more sensible by the yellow fire that gleamed upon the horizon to the south, and aggravated by the deep-toned thunder which rolled at intervals on the mountain, accompanied by the quick rapidity of that forked lightning, whose eccentric course, and dire effects, set all description at defiance. By half-past nine, the hands were sent aloft to furl top-gallant-sails, and reef the top-sails, in preparation for the threatening storm. When retiring to rest, a sud-

den cry of St Elmo and St Ann, was heard from those aloft, and fore and aft the deck. An interpreter called lustily down the hatchway, that St Elmo was on board, and desired me to come up. A few steps were sufficient, and, to my great surprise, I found the topsail-yards deserted, the sails loose, and beating in the inconstant breeze, the awe-struck and religious mariners, bare-headed, on their knees, with hands uplifted, in voice and attitude of prayer, in earnest and muttering devotion to St Elmo or St Ann, according to the provincial nature of their speech.

On observing the appearance of the masts, the main-top-gallant-mast-head, from the truck, for three feet down, was perfectly enveloped in a cold blaze of pale phosphorous-looking light, completely embracing the circumference of the mast, and attended with a flitting or creeping motion, as exemplified experimentally by the application of common phosphorus upon a board; and the fore and mizen top-gallant-mast-heads exhibited a similar appearance in a relative degree.

This curious illumination continued with undiminished intensity for the space of eight or ten minutes, when, becoming gradually fainter and less extensive, it finally disappeared, after a duration of not less than half-an-hour.

The seamen, in the mean time, having finished their devotions, and observing the lights to remain stationary, returned promptly to the yards, and, under favour of this "Spirit of the Storm," now quickly performed that duty, which, on a critical conjuncture, had been abandoned, under the influence of their superstition and their fears. During the prevalence of the lights, as well as through the remaining hours of night, the wind continued, except in occasional puffs, light and variable; and the morning ushered in with a clear sky, a hot sun, and a light southerly breeze, which, in due time, brought us safe to the anchorage of Palma.

Conversing with the interpreter on the nature of this extraordinary atmospherical phenomenon, he expressed his implicit belief that it was provided by the immediate power of St Elmo, the tutelar deity of "those who travel on the vasty deep," in regard to their interests in a moment of sudden danger; and used every argument to persuade me, that the present safety of

the ship was due to the very timeous and friendly interference of this aerial demigod; and that no accident could possibly have happened to the sails, while the seamen were at prayers, as long as the light glowed stationary on the mast. Had the light, he continued, descended gradually from the mast-head to the deck, and from thence to the kelson, as he had often seen it, the event would have prognosticated a gale of wind or other disaster, and, according to the depth of the descent, so would be the nature of the evil to come. In the present instance, the lights gradually disappeared, like the snuff of a candle, and the weather continued clear and fine for several subsequent days.

This phenomenon, by many, is held to be fabulous, and is so alluded to by the greatest living poet of the day:

> "Of witch, of mermaid, and of sprite,
> "Of Erick's cap, and Elmo's light;"

but Falconer, both seaman and poet, writing from experience, says,

> "High on the masts with pale and livid rays,
> "Amid the gloom portentous meteors blaze."

In order, however, to illustrate more fully the character of those very pious and devoted seamen, who attracted the favour of the saint on the present occasion, it must be understood, that this visitation of St Elmo took place immediately on the first burst of the Spanish Revolution, and that these very men had but recently figured as the bloody instigators and perpetrators, along with other patriots, in the massacre of several unfortunate Frenchmen, long resident in the city of Valencia for the peaceful purposes of commerce.

Art. V.—*Account of Captain Scoresby's Magnetical Discoveries, and of his Magnetimeter and Chronometrical Compass.*

SEVERAL interesting and valuable papers by Captain Scoresby, respecting magnetism, having appeared in the Transactions of our learned Societies *, we propose to give a condensed ac-

* *Edinburgh Transactions*, vol. ix. p. 243, 353., and *Philosophical Transactions*, 1822, p. 241.

count of the principal discoveries detailed in these papers, in order to bring into one point of view subjects of very considerable practical importance. In addition to the articles that are already before the public on this subject, we have had the opportunity of witnessing some of Mr Scoresby's experiments, and of examining his magnetical apparatus, and we are therefore enabled to communicate some particulars that have not hitherto been laid before the public.

Mr Scoresby's attention was first directed to the investigation of the magnetic laws, in consequence of a series of experiments undertaken by him in the years 1815 and 1817, for determining the cause of the "deviation of the compass" on ship-board. In trying the magnetic properties of different masses of iron about the ship's deck, he found, what, indeed, was long before known to be the fact, that, in the high northern latitudes, all rods of iron, in a vertical position, were magnetical, while the same rods placed nearly horizontal, exerted little or no influence on the compass. The result of his inquiries into the law of the magnetic action was such as might have been expected, namely, that ferruginous substances became magnetical by position, the upper parts, as respects the plane of the magnetic equator intersecting them through the centre of gravity, acquiring south polarity, and the lower parts north polarity. But while this law seems universally to prevail, it exhibits an apparent modification by experiment, in the case of slender bars or thin plates of iron; for these bodies, when placed in the magnetic plane, exhibit no magnetic action on a compass; because the magnetic axis in them corresponding with their shortest axis, the two poles are so near together that they neutralize each other, with respect to their effects upon the compass.

As the magnetic plane may be readily discovered by experiment, with slender bars of iron free from permanent magnetism, Mr Scoresby constructed an instrument, called a *Magnetimeter*, with which the exact angle where the polarity of iron disappears may be determined; and this he finds gives him the complement of the dip, with such a degree of accuracy as in most respects to answer the ends of a dipping-needle.

"For examining into the phenomena of the polarity of iron arising from position, &c., I constructed, (says he) about the month of December 1819, an apparatus, of which, with improve-

ments recently made, the following is a description. It consists of a small table of brass, A, Plate I, Fig. 1, 4½ inches square, and 3¾ inches high, having a plate of brass C attached to it by hinges, and moveable by means of the wheel and pinion D, E, through an arch of 250 degrees of a vertical circle. This plate has a small straight groove running from end to end, in the line *a a*, for the purpose of receiving bars of metal, the polarity of which is to be determined. These bars are readily fixed to the plate, by being slipped through a circular aperture in the end of a spring *b*, which, perforating the moveable plate, and acting downward, firmly embraces any substance laid along the groove. The angular position of the moveable plate is marked by a circle FF, screwed upon the side of the table. It is graduated so as to mark the angle between the moveable plate and the horizontal plane, whether above or below it. To insure accuracy in this angle, the true horizontal position of the table, and with it the horizontal line on the circle, is determined by means of a spirit-level G; and that the movements of the plane may be accurate, and the angle marked true, the pin which passes through the hinges also forms the centre of the wheel D, and terminates exactly in the centre of the graduated circle F. H is a moveable flat plate of brass, divided into rhumbs and degrees: it is furnished with a magnetic needle, having an agate cap traversing on a brass or steel point. The needle can be changed according to the nature of the circumstances; a very lightly and strongly magnetized one being used in delicate experiments. The compass or plate carrying the needle, being moveable, its distance from the bar resting on the limb C, may be varied at pleasure. The centre of the hinges is one-tenth of an inch above the level of the table; the magnetized needle stands at the same elevation; and the bars in use being one-fourth of an inch diameter, are sunk in the groove of the moveable plate to such a depth, that their axis, or centre, precisely corresponds with the centre of the hinges; hence the middle of the extremity of each bar is at the same elevation, and at the same distance from the needle in every position of the moveable limb. To give firmness to the instrument in making experiments, the table is fixed by the feet to a mass of lead I, of seven or eight pounds weight. By means of this plate of lead, which has a screw *d* at each corner, the whole apparatus is readily put into a horizontal position. As

the instrument is put together by screws, it can be easily taken to pieces, so as to become exceedingly portable *."

In using this instrument for measuring small magnetic attractions, and enabling him to present a piece of iron to a compass at different times invariably at the same angle and distance, he could ascertain, if, by any treatment to which it might in the mean time have been subjected, any change whatever had taken place in its state as to magnetism. He then observed, that any kind of mechanical action upon a bar of iron, produced a change in its magnetical state, which, on being fully investigated, was found to follow a similar law as that of magnetism of position, with regard to the quality of the magnetism produced. Dr Gilbert, indeed, two hundred years ago, discovered that iron, when hammered in the magnetic meridian, became magnetical, in so far as, when made red-hot, and drawn out in this position, to be able to conform itself to the magnetic north and south, when floated by a piece of cork upon water. But Mr S. went much farther. He ascertained, as it was reasonable to expect, that a horizontal position in the magnetic meridian was by no means the best position for the development of magnetism by percussion; but that the position of the dipping needle given to bars of iron, when hammered, produced the highest effect. A single blow with a hammer, on a bar of soft iron, held vertically, was found to be capable of giving it a strong magnetic action on the compass, the upper end becoming a south pole, and the lower a north pole; and that, on inverting the bar, another blow was found sufficient to change the polarity formerly given to it. But one of the most curious and important effects of percussion observed by Mr S. was found to be this, that a blow, struck upon any part of a bar of iron, while held in the plane of the magnetic equator, (which is horizontal E. and W., or with the north end elevated about 19 degrees above the horizontal in this country), has an invariable tendency to destroy its magnetic action, which it generally does so effectually as to prevent its exerting any influence over a compass, when presented to it in the same plane of the magnetic equator.

Mr Scoresby was led to apply this property to some important purposes. "Previously no other method was known of free-

* *Edinburgh Transactions*, vol. ix. p. 244.

ing iron or steel completely from magnetism, but that of heating it red-hot, and allowing it to cool in a horizontal position east and west. This process, however, besides spoiling the surface of the metal, is troublesome, and seldom completely effectual in its application. But the same object is accomplished, in a moment, and with infinitely better effect, by Mr Scoresby's process, merely by a slight blow or two with a hammer, while the iron or steel is held in the magnetic plane, and is equally applicable to very large and heavy bars, which could not, without great inconvenience, and a fire made on purpose, be heated uniformly to a state of ignition.

Another application of this discovery, is the correction of the magnetism usually found in the balances of chronometers, which produces a serious error in the rate of some instruments. Mr S. found, that any other mechanical action on iron was productive of magnetism, as well as that of percussion, though not in an equal degree. Thus, the different actions of grinding, filing, polishing, drilling, turning, twisting, bending, &c. were all found to elicit magnetic attraction, when performed in a vertical position, or any position out of the magnetic plane; but that the same processes were destructive of polarity, when performed on a bar or plate of untempered metal, when held in the plane of the magnetic equator. Hence, the balances of chronometers, which are usually formed principally of steel, become magnetic in turning them into form, perhaps in a vertical plane, and polishing them in a horizontal plane; but the acquisition of magnetism would no doubt be prevented, and even destroyed if they had previously obtained it, by performing these processes in the plane of the magnetic equator.

The next branch of this science to which Mr S. seems to have turned his attention, was the examination of the laws of percussion, in developing magnetism in different kinds of ferruginous substances, the investigation of the best processes for carrying the magnetism elicited by this means to its highest effect, and the application of the results obtained to useful and practical purposes.

1. Mr Scoresby found that soft steel received the greatest degree of magnetic energy by percussion. In soft iron the magnetism was strong but evanescent. In hard steel and cast-iron weak, but permanent. 2. A bar of soft steel, 6½ inches in length,

$\frac{1}{4}$ inch in diameter, weight 392 grains, hammered in a vertical position, while held on a surface of metal not ferruginous, or even upon iron or steel, if placed horizontally, like the surface of an anvil, or upon a mass of stone, acquired, after seventeen blows, a lifting power of $6\frac{1}{2}$ grains; but a repetition of the blows was productive of no higher energy.

"As magnetism in steel is more readily developed by the contact of magnetizable substances, and particularly if these substances be already magnetic," it occurred to Mr S., "that the magnetizing effects of percussion might be greatly increased, by hammering the steel-bar with its lower end resting on the upper end of a large rod of iron or soft steel, both the masses being held in a vertical position; and that, if the rod were first rendered magnetic by hammering, the effect on the bar would probably be augmented *." The experiments instituted to ascertain the effect of such treatment fully proved that these opinions were correct.

The same soft steel-bar that could only be made to lift $6\frac{1}{2}$ grains when hammered while resting upon a surface of stone or metal not ferruginous, when hammered vertically upon a parlour poker, also held erect, lifted a nail of 88 grains weight, after twenty-two blows. "When the poker had been previously hammered in a vertical position, an increase of magneti effect on the bar was obtained, a single blow being now sufficient to enable the bar to lift about 20 grains;" and, in one instance, ten blows produced a lifting power of 188 grains in the bar, being nearly one-third of its own weight.

A single blow struck upon the bar when held with the other end up, almost destroyed its magnetism, and two additional blows changed its poles.

A difference of power was found to be obtained by using bars of different lengths; that is, there was an increase of attraction in bars of the same diameters, when the lengths were increased.

2. In another series of experiments, Mr S. found, that small or slender bars acquired a much greater lifting power, in proportion to their weight, than large bars. Thus, a piece of a knitting needle, 4 inches long, and weighing 28 grains, which was found

---

* *Phil. Trans.* 1822, p. 245.

to be free from magnetism before the experiment, was made to lift 54 grains, or very nearly twice its own weight, by being repeatedly hammered, while held vertically on the top of a kitchen poker.

The quantity of magnetism developed by this process, Mr S. found increased by a frequent repetition of the experiment with the same bars. Though it was necessary to use the same end downward, generally in the production of the highest effect, it did no harm to knock the magnetism occasionally out by inverting the bars. It is necessary to observe, that, in trying the lifting power of bars or needles after hammering, the nails, which are the most convenient to be used for this purpose, should have their points filed smooth round, and partly polished; otherwise the bad contact occasioned by the oxide on the point or head of the nail, may cause the experiment apparently to fail. With this precaution, there is little doubt of any one succeeding in the experiments, using only a hammer, a poker (previously struck a few blows while held vertically), and a piece of steel wire not tempered.

3. The practical application of this discovery by Mr S., is the formation of artificial magnets, and the ready construction of a compass, without the use of a magnet, at sea.

"Such a high degree of magnetic energy (says he) being obtained by a process so simple, it suggested a ready means of making magnets, without the use of any magnetized substance whatever, and of giving polarity to needles, so as to render them capable of answering the purpose of compasses, in an instant. This application of the process induces me to be more explicit on this incidental subject, because of its importance to seafaring persons. There are instances on record, of the compasses of ships being spoiled by lightning *: The above process would enable

* In the Philosophical Transactions (vol. xi. p. 647.), is an account of a stroke of lightning received on a vessel in the parallel of Bermudas, which carried away the foremast, split some of the sails, and damaged the rigging: and, in addition to these extraordinary effects, it inverted the polarity of the compass, so that the north point became directed towards the south. This induced the navigators, who were not aware of the change, to steer back again, supposing that the wind had shifted; and it was not until they were accidentally set right by another ship, that they discovered the truth.

Another circumstance a good deal similar to this, also mentioned in the Philo-

the navigator to restore sufficient polarity for the guidance of his ship, in a few seconds. And, in cases of vessels foundering at sea, or being destroyed by fire or lightning, in which the crew are compelled to take refuge in the boats at a moment's warning, and without having time to secure a compass, (a case which has occurred hundreds of times), the same process might enable the distressed voyagers to give polarity to the blade of a penknife, or the limb of a pair of scissors, or even to an iron nail, which would probably be sufficient, when suspended by a thread, to guide them in their course through their perilous navigation."

We have seen Mr Scoresby's experiment illustrative of the practicability of this. He used a small bar of soft steel, with a hole drilled two-thirds through it, so as to be capable of turning on the point of a needle. One blow with a hammer when it was held vertically on a poker, gave it such magnetic energy, that it traversed with great celerity.

"Being desirous (says he) of applying the process to the construction of powerful artificial magnets, I prepared (with the assistance of the armourer on board) six bars of soft steel, and bars properly tempered, suitable for a large compound magnet. The soft steel bars were nearly eight inches long, half an inch broad, and a sixth of an inch thick. The bars for the compound magnet, seven in number, which were of the horse-shoe form, were each two feet long before they were curved, and eleven inches from the crown to the end, when finished, one inch broad, and three-eighths thick. These bars were combined by three pins passing through the whole, and screwing into the last; and any number of them could be united into one magnet, by means of

sophical Transactions, occurred in the year 1748—9, on the 9th of January. The ship Dover, on its way from New-York to London, was struck by lightning during a fierce storm, which was encountered in the latitude of 47° 30′ N. and longitude 22° 15′ W. On receiving the shock, the captain, and most of the crew, were for a while disabled in their limbs, or by blindness,—the main-mast was almost perforated,—the upper and lower decks and quick work were stove,—the cabins, bulk-heads, and one of the main lodging-knees of the beams were started or drove down: and, among several other singular circumstances, the magnetism of all the compasses (four in number) was destroyed, or the poles inverted.

a spare set of pins screwed throughout their length, and furnished with nuts. In addition to these bars, &c. I provided separate feeders or conductors of soft iron, suitable for connecting the poles of each of the bars of the compound magnet, and also another conductor, fitted to the whole when combined. With this apparatus, I proceeded to give the magnetic virtue as follows.

I took a rod of soft steel, which I considered better than a poker, and hammered it for a minute or two, while held vertically upon a large bar of soft iron in the same position. This gave considerable magnetism to the steel rod. On the top of this, I then hammered each of the six bars of soft steel, until the accession of lifting power ceased. Then fixing two of them on a board, with their different poles opposite, and formed, by a feeder at each end, into a parallelogram, I rubbed these, after the manner of Canton*, by means of the other four bars, and found their magnetism greatly augmented. The other four bars were operated upon in pairs, in a similar way, those already strengthened being used for strengthening the others, and each pair being successively changed, until all the bars were found to be magnetized to saturation. A pair of them now possessed a lifting power of two pounds and a half.

The next step was to touch the bars intended for the compound magnet, by means of these six bars now magnetized. For this purpose, the six bars were combined into two magnets, by tying three of them together, with similar poles in contact; these two were then placed, with opposite poles in connection, and tied together at one end, but separated about the third of an inch at the other, so as to form one compound magnet, and a conductor was kept constantly applied to the open end of it, when not in use, to preserve the power from being lost. One of the bars of the horse-shoe magnet, with a conductor placed across the poles, was now placed on a board, in a groove cut out so as to hold it fast under the operation. The straight bar magnet was then placed erect on the middle of it with the separated poles downward, and rubbed against the horse-shoe bar, from the middle to one of its poles, until the north pole of the

* See *Phil. Trans.*, vol. xlvii. p. 31.

one was in connection with the pole intended to become south of the other; from thence it was rubbed back again, with the south pole of the magnet in advance, as far as the other extremity, or that intended for the north pole of the horse-shoe bar. Two or three strokes of this kind being made from end to end of the bar, on each side of it, the north and south poles of the magnet being always directed to the south and north poles of the bar respectively, the magnet was slipped sideways off, when at the pole of the bar, and the bar was found to have acquired such a magnetic power as to enable it to sustain a weight of several ounces, hung from the conductor. Each of the bars of the horse-shoe magnet was treated this way in succession, and then the first five bars of the magnet being combined by the screws, were employed in the same way as the soft steel magnet had been used, for increasing the power of the sixth and seventh bars, by which they were rendered capable of carrying above two pounds weight each. These were then substituted, in the combined magnet, for the fourth and fifth bars, while the latter underwent the touch of the other five in combination; and, in their turn, the second and third, and then the seventh and first, were subjected to a similar treatment. After these operations, which occupied forty-three minutes, the compound magnet, with all the seven bars in connection, lifted ten pounds. After a second series of the same kind of manipulations, five of the bars in combination, carried fifteen pounds; and, after a third series, eighteen pounds; but as, on trying a fifth series, little augmentation took place, the process was discontinued. The whole of the operations, from beginning to end, occupied above four hours; but, as I generally rubbed each bar with twelve strokes on each side, instead of one or two, which I afterwards found sufficient; and, in other parts of the process, spent a great deal of time and labour which turned to no account; I doubt not but the whole might have been completed, beginning without the smallest perceptible magnetism, and ending with a lifting power of twenty or thirty pounds, in the space of two hours, or less *.

* "Canton, it is well known, produced magnets by means of a poker and tongs, with bars of soft steel. His process being fully stated in the Philosophical Transactions, some of the above details would perhaps be anticipated by the reader; but they may not be uninteresting to those who are little acquainted with the subject, especially as the fundamental process is original, and much more ready and effi

As steel does not receive, immediately on being touched, the full degree of magnetic energy of which it is susceptible, a conductor was applied to the magnet now formed; and it was laid aside, with the view of augmenting its power on a subsequent occasion.*"

The errors produced in the rates of Chronometers, by the magnetism of their balances, a subject of great consequence to navigators, has occupied a good deal of the attention of Captain Scoresby.

It has long been known that when chronometers are taken to sea, a change is generally found to take place in the rate determined on shore.

"This change of rate," says Mr Scoresby, "that had usually been supposed to arise from the motion of the ship, has recently been attributed, by Mr Fisher, who accompanied Captain Buchan in his Voyage towards the North Pole in the year 1818, 'to the magnetic action exerted by the iron in the ship upon the inner rim of the Chronometer's balance, which is composed of steel.' I apprehend, however, that it will be very easy to shew, that, although the alteration of rate may be, and most probably is, owing to magnetism, yet the magnetic action of the iron in the ship, excepting in cases where chronometers are placed in immediate contact with large masses of iron, can contribute but in a very small degree to the error in question. For, in the same proportion as the magnetism of the earth, or the directive force on the compass-needle, exceeds the magnetism of the ship, or the deviating force, the influence of terrestial magnetism on the chronometer, must, I conceive, exceed that influence exerted by the iron in the ship on the chronometer. A modified action, indeed, takes place where the direction of the magnetic force of the earth differs from the direction of the "local attraction" of the "ship;" but yet the combined influences of the two forces, however modified by direction, should, I imagine, be similar on the balance of the chronometer, which vibrates in a horizontal position, to what it is on the compass-needle, which traverses in the same position.

cient, I apprehend, than that of Canton, one blow with a hammer being capable of developing as much magnetism as a quarter of an hour's labour with a poker and tongs."

* *Journal of a Voyage to Greenland*, p. 56.

Now, the medium effect of the attraction of the iron in vessels on the compass, in the parallels of Great Britain, does not appear to exceed five degrees of deviation on each side of the magnetic meridian; it is probably a little less. The force producing the deviation, therefore, is represented by the sine of the angle of deviation, or 5°; while the directive force is represented by the sine of 85°. The relation of these two, is as 1 to 11.35; that is, the directive influence of the earth's magnetism on the compass is $11\frac{1}{3}$ times greater than the deviating influence of the local attraction. Hence, the proportion of error due to the local attraction of the ship, would appear not to exceed, in these latitudes, the eleventh or twelfth part of that resulting from the earth's magnetism; while, nearer the equator, this proportion of error must be still less. So long as the action of terrestrial magnetism, therefore, remains uncorrected, it will be of little service to compensate for the error arising from the local attraction. In the Polar Seas, indeed, the force of local attraction approaches the directive force much nearer than in the British Seas; and, in some situations very near the Magnetic Poles, exceeds it; but still the local attraction operates without any increase of force, excepting what may arise from the little augmentation of the magnetic intensity of the earth in those regions; so that, in reality, the rate of a Chronometer in polar regions, where the earth's magnetism acts nearly at right angles to the plane of the balance, could the effect of temperature on the instrument be perfectly compensated, ought to be more equable than in any other region, where the direction of terrestrial magnetism is more nearly in the plane in which the balance vibrates.

In the important and truly scientific experiments of Mr Barlow, on the effects produced on the rates of chronometers by the proximity of masses of iron, we have a corroboration of the preceding opinions; for Mr Barlow, though he observed that a variation of rate was occasioned by the influence of a mass of iron equivalent to the local attraction of a ship, found by no means so great effects as those observed by Mr Fisher. But the force of terrestrial magnetism acting upon a balance that is magnetic, is fully sufficient to account for every change of rate observed.

Mr S. Varley, in a paper in *Tilloch's Philosophical Magazine*, published in the year 1798, was the first, I believe, who showed

that an irregularity observed in the rate of some time-pieces, was owing to the magnetic state of their balances. He was directed to the inquiry by a watch of excellent workmanship that he had in his possession, which performed the most irregularly of any watch he had ever seen. It occurred to him that the cause might be magnetism; and, on examining the balance, he found it so strongly magnetic, that, when suspended horizontally without the spring, it directed itself like a compass-needle in a certain position, which it invariably returned to when it was disturbed. The pendulum spring being put on, and the balance replaced in the watch, Mr Varley laid the watch with the dial upward, and the north pole of the balance, as determined by the previous experiment, towards the north;—in this situation it *gained* 5′ 35″ in twenty-four hours. He then directed the north-pole of the balance towards the south, every thing else being as before, and it now *lost* 6′ 48″ in twenty-four hours. Mr Varley afterwards took away the steel-balance, and substituted one made of gold; then having brought the watch to time, he carefully observed its rate, and found it as uniform as any watch of like construction. He subsequently examined many dozens of balances, out of which he could not select one that had not polarity.*"

The instance observed by Mr Varley was, no doubt, an extreme one; but analogous effects are not uncommon. Captain Scoresby made a number of experiments on the rates of chronometers in different positions, and found, that in twelve or fourteen chronometers, a sensible alteration of rate took place in about one-half of them, without any alteration of position.

" In a pocket chronometer," says he, " by Allen and Caithness, the rate was very uniform in two positions (namely, with the 12 o'clock mark towards the NE. and SW.); but on shifting it from NE. to SE., a change of 1″.5 took place in its rate. In another chronometer by Hatton, there appeared to be a difference of rate of about a second in two opposite positions. In a one-day chronometer by Litherland and Davies, there was scarcely any perceptible variation in three positions, namely N., S. and E.; but, on the 12 o'clock mark being directed towards the W., a change of one second per day occurred. In another

* *Edinburgh Transactions*. vol. ix. p. 353.

instrument by the same makers, between the NW. and SE. positions, there was a difference, by the first experiment, of 2".3 per day, and by the second experiment, of 1".1. In an eight-day chronometer, by Margetts, there was also a sensible effect produced by an alteration of position. But the most extraordinary result was with an eight-day chronometer. When the position was kept uniform, the rate of this instrument was very fair: but, on shifting it from NE. to SW., it was retarded 4".4 daily. On restoring it to its first position, it was again accelerated even beyond its former rate. The same change was repeatedly made, and in all cases, an alteration of from 1".4 to 9".5 per day occurred; and, in every instance when the change was made from NE. to SW., the rate was retarded; when the contrary way, accelerated! Between the positions of SE. and NW., there was also a difference of rate, but it was not very considerable.

"As the experiments with the last instrument were by far the most decisive, I was desirous of examining the balance,—a wish that Mr Davies very readily gratified. It was found to be strongly magnetic, acting with great energy on a small needle, at the distance of more than an inch. Mr Davies having got rid of the greater part of the magnetism of this balance, restored it to its place, when the change of rate, by changing its position, though it did not entirely disappear, was got reduced to about one-fourth. The balance of another chronometer by the same makers, whose rate in all positions was remarkably uniform, was also examined, and it was satisfactory to find that it was entirely free from magnetism *."

Captain S. we have observed, proposes to get rid of the magnetism in the balances of chronometers, by turning and grinding them in the plane of the magnetic equator. But he suggests another means of rectifying the errors of chronometers, where balances are magnetic, by suspending them on an instrument, called a *Chronometrical Compass*, which he has contrived for the purpose, and which always keeps them in the same position at sea, with respect to the magnetic meridian. This instrument, shewn in Plate I. Fig. 2., consists of a slender cross of brass,

* *Journal of a Voyage to Greenland*, p. 9.

supported on a long point of brass or steel in a compass bowl, from which is suspended a rhomboidal compass-needle. On the center of the brass cross there is a light case of card paper fitted to the pocket chronometer to be carried by it. The case for the chronometer slips upon two pins rivetted to a moveable plate upon the cross, which being made to slide in different directions, may be so placed as to adjust the chronometer fairly over the centre of the needle, and is then fastened by screws. In this state, the magnetic needle below it causes the cross and chronometer to traverse with great celerity. It therefore has the property of keeping the chronometer invariably in the same position, and, being suspended on gimbals, of preserving it from the bad effects of the motion of the ship at sea. The magnetic needle was hung five or six inches below the chronometer, so that its influence on the instrument was not greater than that of the earth; and, being in an opposite direction, has a tendency to neutralize, rather than add to, this disturbing cause *.

This apparatus was tried at sea, and proved to answer the desired purpose in a most admirable manner. In one of the heaviest gales experienced on Captain Scoresby's last voyage, the chronometer on the apparatus traversed perfectly, and was steadier than any of the compasses.

Art. VI.—*Description of Achmite, a New Mineral from Norway, found and described by* P. Strom †.

This fossil occurs only crystallised. Externally it is of a dark brown colour, inclining to red, and in the fracture greenish-black. The lustre of the cleavage is vitreous, and the cross fracture dull, but somewhat glistening. It is feebly translucent on very thin edges. It scratches glass, and its specific gravity is 3.24. It presents a rhomboidal prism, with truncated edges, and with very acute summits. It has four cleavages parallel to the longitudinal faces of the prism MM*re*, Plate IV. Fig. 1. the two first of which are more perfect than the two last. In other directions the fracture is uneven, and nearly earthy. According

---

* This instrument is described in the *Edin. Trans.*, vol. ix. p. 364.

† Abstracted from the *Annals of the Academy of Sciences at Stockholm for* 1821, p 160.

to Professor Mitscherlich's measurements with the reflecting goniometer,

$$\begin{aligned} M : M &= 86^\circ\ 56' \\ M : r &= 133\ \ 28 \\ M : e &= 136\ \ 32 \\ s : s &= 35\ \ \ 0 \\ s : r &= 162\ \ 30 \\ t : t &= 28\ \ 19 \\ t : e &= 165\ \ 15\tfrac{1}{2} \end{aligned}$$

The angle of the edge, $t = 104^\circ\ 26'$

And of the edge, $s = 80^\circ$. $o : r = 140$.

The facets of the prism corresponding with the cleavages are very perfect, but the terminal facets are less so, and therefore the above measures of their inclination may deviate a little from the true angles. It melts readily before the blowpipe into a black globule.

This mineral occurs in the parish of Eger, in the south of Norway. It is found in nodules of quartz, disposed in a granite, which, according to Hausmann and Von Buch, belongs to the transition formation, and the crystals appear to radiate from the granite into the quartz.

According to the analysis of Professor Berzelius, this mineral contains

Silica, . .	55.25
Oxide of Iron, . .	31.2
Oxide of Manganese, .	1.08
Lime, . . .	0.72
Soda, ...	10.40
	99.70

If the minute quantities of lime and manganese be regarded as replacing a corresponding quantity of soda, the formula representing its composition is $= NS^3 + 3FS^2$.

As Haüy has derived the name of Axinite from the axe-shaped form of the crystal which bears that name, Berzelius has given that of *Achmite* (from ακμη, *a point*) to this new and very remarkable substance *.

* In the cabinet of Mr Allan, there is a large and well defined crystal of this substance, which he some years ago received as an unknown mineral from Norway. The particular locality was not given. It presents additional facets, not only on the edges of the rhomboidal prism, but on the summit of the acute pyramid. The latter are so small, that it is not easy to give their precise measurement. By examining a fragment of this crystal, Dr Brewster found that it possessed double refraction in a very considerable degree.—Ed.

ART. VII.—*On the Measurement of the Progress of an Eclipse of the Moon with a Sextant, or Reflecting Circle.* By T. E. BOWDICH, Esq. Communicated by the Author.

IT is impossible to observe the beginning of an eclipse of the Sun or Moon on shipboard, with precision, but by measuring the progress of either with a sextant, at intervals of five minutes. Advantage may still be taken of these phenomena, for the determination of the longitude.

This method offers the great advantage of multiplying the angles, and consequently of diminishing the errors by which the partial observations may be affected.

It was first proposed for eclipses of the Sun by Wales, who thus observed that of 1774. King, who accompanied Captain Cook in 1777, also availed himself of it; but, in both instances, the mere observations are recorded, without calculation, formula, or result.

Köhler appears to have been the first who recommended, and Humboldt the first who put in practice, the application of this method to eclipses of the Moon. The latter thus determined the longitude of Ibague within $\frac{1}{8}$th of a degree; but as Oltmans, who calculated this observation, has merely given us the result, without the formula, and as I do not know of any formula being in print, I thought it might be useful, as well as interesting, to submit the following, which is general, until a neater one may be discovered.

Let Δ = longitude ☽ — long. ☉ — 180°.

λ = latitude of ☽.

$\Delta_{,}$ = augmentation of the relative longitude of ☽.

$\lambda_{,}$ = movement in latitude of ☽.

δ = semi-diameter of ☉.

δ' = do. ☽.

p = parallax of ☉.

p' do. ☽.

ϵ = enlightened part of ☽ in minutes.

t = the time before or after the instant of calculating the long. of ☽.

T = time for which the above elements (from the Naut. Alman.) are calculated.

T' = mean time of the observation.

To determine the relative orbit of the ☽ we have,

$$x = ay + b \quad x = \Delta \quad y = \lambda \quad \Delta + a\lambda = b$$
$$x = \Delta' \quad y = \lambda' \quad \Delta' + a\lambda' = b.$$

by which latter equations we may determine a and b; but we need not recur to these equations, observing, see Plate IV. Fig. 2. that when

$$t = 0 \quad x = \Delta \qquad y = \lambda$$
$$t = 1 \quad x = \Delta + \Delta' \quad y = \lambda + \lambda'$$
$$t = \tfrac{1}{2} \quad x = \Delta + \tfrac{1}{2}\Delta' \quad y = \lambda + \tfrac{1}{2}\lambda';$$

whence the general expression, $x = \Delta + t\Delta' \quad y = \lambda + t\lambda'$, which gives us the value of x and y in time, and enables us to determine the place of the ☽ at each instant.

To determine the distance of the centre of moon and cone of umbra at any moment, we have (calling the radius of the cone of umbra ϱ), see Fig. 3.

$$D^2 = x^2 + y^2 = (\Delta_{,}^2 + \lambda_{,}^2)\,t^2 + 2(\Delta\Delta_{,} + \lambda\lambda_{,})\,t + \Delta^2 + \lambda^2$$
$$0☽ = D \quad D + ☽b - \varrho = \iota \quad D^2 = (\iota + \varrho + \gamma)^2$$
$$(\iota + \varrho - \gamma)^2 = (\Delta_{,}^2 + \lambda_{,}^2)\,t^2 + 2(\Delta\Delta_{,} + \lambda\lambda_{,})\,t + \Delta^2 + \lambda^2$$

To find the value of ϱ, we have

$$ST = \frac{TT'}{\text{tang}\,p} \qquad SS' = \frac{TT'\,\text{tang}\,\delta}{\text{tang}\,p} \qquad TR = \frac{TT'}{\text{tang}\,p'}$$

JT:JR::TT':RR'; JS:JT::SS':TT'; JS—JT:JT::SS'—TT':TT'

$$\frac{TT'}{\text{tang}\,p} : JT :: \frac{TT'\,(\text{tang}\,\delta - \text{tang}\,p)}{\text{tang}\,p} : TT' \quad JT = \frac{TT'}{\text{tang}\,\delta - \text{tang}\,p}$$

$$JR = JT - TR = \frac{TT'}{\text{tang}\,\delta - \text{tang}\,p} - \frac{TT'}{\text{tang}\,p'}$$

$$JR = \frac{(\text{tang}\,p' - \text{tang}\,\delta + \text{tang}\,p)\,TT'}{\text{tang}\,p'\,(\text{tang}\,\delta - \text{tang}\,p)}$$

$$\frac{TT'}{\text{tang}\,\delta - \text{tang}\,p} : \frac{(\text{tang}\,p - \text{tang}\,\delta + \text{tang}\,p')\,TT'}{\text{tang}\,p'\,(\text{tang}\,\delta - \text{tang}\,p)} :: TT' : RR'$$

$$RR' = \frac{TT'\,(\text{tang}\,p - \text{tang}\,\delta + \text{tang}\,p')}{\text{tang}\,p'} \qquad \text{tang}\,\varrho = \frac{RR'}{TR} =$$

$$\text{tang}\,p - \text{tang}\,\delta + \text{tang}\,p',$$

$$\text{tang}\,\varrho = \text{tang}\,p + \text{tang}\,p' - \text{tang}\,\delta \qquad \varrho = p + p' - \delta;$$

$$\therefore (\Delta_{,}^2 + \lambda_{,}^2)\,t^2 + 2(\Delta\Delta_{,} + \lambda\lambda_{,})\,t + \Delta^2 + \lambda^2 = \gamma^2 = (\iota - \gamma + p + p' - \delta)^2$$

$$t^2 + 2\,\frac{(\Delta\Delta_{,} + \lambda\lambda_{,})}{\Delta_{,}^2 + \lambda_{,}^2}\,t = \frac{(\iota - \gamma + p + p' - \delta)^2 - \Delta^2 - \lambda^2}{\Delta_{,}^2 + \lambda_{,}^2}$$

and making $r = (p + p' - \delta) - \gamma$ *, we have, see Fig. 4.

$$t = \frac{-\Delta\Delta_{,} - \lambda\lambda' \pm \sqrt{(\Delta\Delta_{,} + \lambda\lambda_{,})^2 + (\Delta_{,}^2 + \lambda_{,}^2)\left\{(r+\iota)^2 - \Delta^2 - \lambda^2\right\}}}{\Delta_{,}^2 + \lambda_{,}^2}.$$

Thus, this problem serves to determine the longitude, when we have observed ι, and the relative time at the place; for, designating this time by T′, that of the calculation of the elements by T (which must be taken near the opposition), we have the longitude expressed in time by the formula $l = t - T$, being west if l is positive, and east if it be negative.

The discussion of this formula shews, that if we make the quantity under the radical $= 0$, *i. e.*

$$(\Delta\Delta_{,} + \lambda\lambda_{,})^2 + (\Delta_{,}^2 + \lambda_{,}^2)\left\{(r + \iota)^2 - \Delta^2 - \lambda^2\right\} = 0,$$

and derive the value of $(r + \iota)$ therefrom,

$$r + \iota = \sqrt{\Delta^2 + \lambda^2 - \frac{(\Delta\Delta_{,} + \lambda\lambda_{,})^2}{\Delta_{,}^2 + \lambda_{,}^2}}$$

it will be the value of the shortest distance between the centres of the conus umbræ and the ☽.

The time will be given by the equation

$$t = \frac{-\Delta\Delta_{,} - \lambda\lambda_{,}}{\Delta_{,}^2 + \lambda_{,}^2} + T,$$

in which t indicates the middle of the eclipse.

If we would have the beginning and the end of the eclipse, we make $\iota = 2\gamma$, and the time of each will be given by the equations,

$$t = \frac{-\Delta\Delta_{,} - \lambda\lambda_{,} \pm \sqrt{(\Delta\Delta_{,} + \lambda\lambda_{,})^2 + (\Delta_{,}^2 + \lambda_{,}^2)\left\{(r + 2\gamma)^2 - \Delta^2 - \lambda^2\right\}}}{\Delta_{,}^2 + \lambda_{,}^2} + T$$

taking the sign — for the beginning, and + for the end.

---

* Or faisant $r = \frac{61}{60}(p + p' - \delta) - \delta'$, "Pour faire ces calculs de demi-durée, on fait ordinairement le rayon de l'ombre $\frac{61}{60}(\varpi + \pi - \delta)$, parce qu'on a remarqué que les durées observées étaient toujours plus longues que le durées calculées, ce qu'on attribue à l'atmosphère de la terre, qui intercepte la lumière du soleil, et fait le même effet que produirait une augmentation d'environ $\frac{1}{60}$ dans le rayon de la terre. Cette évaluation paraît bien considerable.—Delambre, *Astronomie*, p. 350.

The duration of the eclipse will be given by

$$\tfrac{1}{2}\mathrm{D}=\sqrt{\frac{(\Delta\Delta_{,}+\lambda\lambda_{,})^{2}+(\Delta_{,}^{2}+\lambda_{,}^{2})\left\{(r+2\delta)^{2}-\Delta^{2}-\lambda^{2}\right\}}{\Delta_{,}^{2}+\lambda_{,}^{2}}}$$

If we desire the end of the immersion and the beginning of the emersion, we make $s=o$, and the times will be given by the equation

$$t=\frac{-\Delta\Delta_{,}-\lambda\lambda_{,}\pm\sqrt{(\Delta\Delta_{,}+\lambda\lambda_{,})^{2}+(\Delta_{,}^{2}+\lambda_{,}^{2})(r^{2}-\Delta^{2}-\lambda^{2})}}{\Delta_{,}^{2}+\lambda_{,}^{2}}+\mathrm{T},$$

being after the middle of the eclipse, if we take the sign + of the radical, and before if we take —.

Let I represent the duration of the total immersion of the ☽, *i. e.* the time during which she remains completely invisible, and we have

$$\tfrac{1}{2}\mathrm{I}=\sqrt{\frac{(\Delta\Delta_{,}+\lambda\lambda_{,})^{2}+(\Delta_{,}^{2}+\lambda_{,}^{2})(r^{2}-\Delta^{2}-\lambda^{2})}{\Delta_{,}^{2}+\lambda_{,}^{2}}}$$

Lastly, we have the hour to which any enlightened part s corresponds, by making s equal to this part, and deducting the corresponding value of t.

In all these equations, we use or repeat nearly the same logarithms, which very much expedites the calculation.

Let us suppose that we have measured the chord of distance between the two horns of the Moon, which seems to me to admit of more precision; we have only to make the following additions in the original expressions for the elements:

$c=\tfrac{1}{2}$ distance of the horns of ☽,

$t'=$ mean time of the observation of c,

$r=\frac{61}{60}(p+p'-\delta)=$ radius of the section of the conus umbræ,

$\alpha=\Delta_{,}t+\Delta \quad \beta=\lambda_{,}t+\lambda \quad y=ax \quad a=\frac{y}{x}=\frac{\beta}{\alpha},$

tang $i=a \quad$ sin $i=\beta \quad$ cos $i=\alpha$

$y=\beta x'+\alpha y' \quad x=\alpha x'-\beta y'$ (Biot, *Geom. Anal.* No. 77.)

$x'^{2}+y'^{2}=r^{2}$ Equation of circle of conus umbræ.

$y'^{2}+(x'-\mathrm{D})^{2}=\delta^{2}$ Equation of circumference of ☽ referred to 2d axis. See Fig. 5.

$$r^2 - x'^2 + x'^2 - 2Dx' + D^2 = \gamma^2 \quad x' = \frac{D^2 + r^2 - \gamma^2}{2D},$$

$$x'^2 = \frac{D^4 + r^4 + \gamma^4 + 2D^2r^2 - 2D^2\gamma^2 - 2r^2\gamma^2}{4D^2},$$

$$y'^2 = r^2 - x'^2 = \frac{-D^4 - r^4 - \gamma^4 + 2D^2r^2 + 2D^2\gamma^2 + 2r^2\gamma^2}{4D^2}.$$

making $y = c$, we have

$$4D^2c^2 - D^4 - 2D^2r^2 - 2D^2\gamma^2 = -r^4 - \gamma^4 + 2r^2\gamma^2,$$

$$D^4 + 2D^2(2c^2 - r^2 - \gamma^2) = -r^4 - \gamma^4 + 2r^2\gamma^2,$$

$$D^2 = -(2c^2 - r^2 - \gamma^2) \pm \sqrt{4c^4 + r^4 + \gamma^2 - 4c^2r^2 - 4c^2\gamma^2 + 4\gamma^2r^2},$$

$$D^2 = -(c+r)(c-r) - (c-\gamma)(c+\gamma) \pm 2\sqrt{c^4 - c^2r^2 - c^2\gamma^2 + \gamma^2r^2},$$

$$c^4 - c^2r^2 - c^2\gamma^2 + \gamma^2r^2 = c^2(c^2 - \gamma^2) - r^2(c^2 - \gamma^2) =$$

$$(c^2 - r^2)(c^2 - \gamma^2) = (r+c)(r-c)(\gamma+c)(\gamma-c),$$

$$D^2 = (r+c)(r-c) + (\gamma+c)(\gamma-c) \pm \sqrt{(r+c)(r-c)(\gamma+c)(\gamma-c)},$$

$$A' = (r+c)(r-c) \quad B' = (\gamma+c)(\gamma-c) \quad D^2 = A' + B' + 2\sqrt{A'B'}$$

$$D^2 = \alpha^2 + \beta^2 = (\Delta_{,}^2 + \lambda_{,}^2)t^2 + 2(\Delta\Delta_{,} + \lambda\lambda_{,})t + \Delta^2 + \lambda^2,$$

whence, (making $-\Delta\Delta_{,} - \lambda\lambda_{,} = A \quad \Delta_{,}^2 + \lambda_{,}^2 = B$)

$$t^2 - \frac{2At}{B} = \frac{D^2 - \Delta^2 - \lambda^2}{B}$$

$$t = \frac{A}{B} \pm \sqrt{\left(\frac{A^2}{B^2}\right) + \frac{D^2 - A^2 - \lambda^2}{B}}$$

The time of the middle of the eclipse is $= T + \frac{A}{B}$.

The 4 roots of the following Equation,

$$t = T + \frac{A}{B} + \sqrt{\left(\frac{A}{B}\right)^2 + \frac{t^2 + \gamma^2 - \Delta^2 - \lambda^2 \pm 2r\gamma}{B}}$$

$$t = T + \frac{A}{B} \pm \sqrt{\left(\frac{A}{B}\right)^2 + \frac{(r \pm \gamma^2) - \Delta^2 - \lambda^2}{B}}$$ (c being

$= 0$), give the beginning of the eclipse,

The end of the immersion,

The beginning of the emersion,

The end of the eclipse.

The duration of the eclipse is $= 2\sqrt{\left(\frac{A}{B}\right)^2 + \frac{(r \pm \gamma)^2 - \Delta^2 - \lambda^2}{B}}$.

The shortest distance between the centre of the Moon and of the section of the conus umbræ (occurring when t is equal to

the time of the middle of the eclipse, or $t = T + \frac{A}{B}$), will be given by the value of D, derived from the equation

$$\left(\frac{A}{B}\right)^2 + \frac{D^2 - \Delta^2 - \lambda^2}{B} = o \qquad D = \sqrt{\Delta^2 + \lambda^2 - \frac{A}{B}A.}$$

Lastly, any enlightened quantity of the Moon, or any distance of the horns, will be given by the formula

$$t = T + \frac{A}{B} \pm \sqrt{\left(\frac{A}{B}\right)^2 + \frac{D^2 - \Delta - \lambda^2}{B}},$$

observing, that, in the former case, $D = r - \gamma' + \iota$,
in the latter, $D^2 = A' + B' \pm 2\sqrt{A'B'}$,

$$A' = (r + c)(r - c) \quad B' = (\gamma' + c)(\gamma' - c);$$

thus we may have the time t expressed in function of ι, or in function of c.

The longitude of the place will be expressed in time by the formula $L = t - t'$, in which t' represents the time of the observation of ι or c; the longitude being east or west, according as L is positive or negative.

Finally, substituting the value of t, we have the longitude expressed in time by the formula,

$$\text{Long.} = T - t' + \left(\frac{A}{B}\right) \pm \sqrt{\left(\frac{A}{B}\right)^2 + \frac{D^2 - \Delta^2 - \lambda^2}{B}}.$$

I have calculated M. de Humboldt's observation at Ibague * by this formula, and the result would no doubt accord precisely with that in the text, were the elements it contains free from errors; for, after correcting the most palpable, my result differs but 27″ from that of M. Oltmans. The following errors cannot be disputed, and other lesser ones certainly exist.

It is impossible that 21^h 20′ 45″ can be the mean time at Paris, since the elements are calculated very near the opposition, and this happened, according to the text, at 19^h 26′ 41″. If we suppose, for a moment, that this latter element is inexact, we may still convince ourselves that 21^h 20′ 45″ cannot be the correct time, by merely observing, that the enlightened part of the

* Voyage de Humboldt, Partie Astronomique, (2 vol. 4to), vol. ii. p. 255.

Moon 23′ 30″ must be near the end of the eclipse, since both the time and the quantity of the enlightened part of the Moon continue augmenting; nevertheless the time of this measurement is 21^h 0′ 13″.9, *i.e.* less than 21^h 20′ 45″, which is evidently absurd. This error of the text leaves no other alternative than to deduct the time for which the observation is calculated from that of the full Moon, which gives us 19^h 27′ 28″.8. Another evident error of the text is detected as follows:

Mean Time at Paris,	21^h 0′ 13″.9	according to the text,
... . Ibague,	15 50 54.9	
Longitude in Time,	5^h 9′ 19″	
instead of - -	5 9 39	given in the text.
Error,	0^h 0′ 20″	

Art. VIII.—*Remarks on the Increase of the Population of the United States and Territories of North America, with Original Tables, deduced from the American Population Returns, to illustrate the various Rates of Increase in the White Population and Slaves, and also the comparative degrees in which Agriculture, Commerce, and Manufactures prevail.* By George Harvey, Esq. M. G. S. M. A. S., &c. (Continued from Vol. VIII. p. 339.)

Slave Population.

EVERY lover of humanity necessarily feels an interest in the condition of that class of our fellow men who are doomed to spend the long range of a miserable existence in a state of slavery. The heart sympathises with their misfortunes, and we eagerly embrace every opportunity, which is likely to throw even but a feeble and uncertain light on their unhappy condition. The returns of the slaves contained in the American Population Tables, are probably the *only* sources from which any satisfactory information can be drawn, to illustrate this very important subject.

It has been already remarked, that in the enumerations of the American people, prior to the census of 1820, the slaves were thrown into one mass, without any distinction as to their sexes,

and much less any divisions relating to their ages. In the census of 1820, however, these very important particulars were attended to; the males being separated from the females, and each sex divided into the four classes alluded to at the commencement of the paper. It was observed also, at the same time, as a circumstance much to be regretted, that the ages of the slaves do not entirely correspond with the classes into which the free males and females were divided; and that, therefore, many interesting comparisons which might otherwise have been made, with the white part of the population, could not, under the present circumstances, be instituted. It would have been interesting, for example, to have been enabled to compare the slave population under ten years of age, with the free white population of the same class, and by this means to have considered, how far the general circumstances of the younger classes of slaves at all assimilate to the state of the free American population of corresponding ages; whether slavery exerts any influence of a very baneful nature on the young; and whether the freedom of the parent does not contribute, in a very powerful degree, to cherish a healthy and vigorous offspring. Some idea of the nature of this influence may be drawn from a Table which will speedily follow. Two classes, however, of the slave population, admit of a direct comparison with the free population; that is, those of twenty-six and under forty-five, and of forty-five and upwards. If, indeed, we regard the aggregate of the classes below the former of these, in each case, as a single class, another comparison may be made, with each sex, below the age of twenty-six.

If we take the total amount of each class of the free white population, in all the provinces, in 1820, it appears, that, for every 100 free white males of 26 and under 45, there were 354 under 26 years of age, and 65 of 45 and upwards; but that for every 100 male slaves of 26 and under 45, there were 334 under 26 years of age, and only 47 of forty-five years and upwards. So also, for every 100 free females of 26 and under 45, there were 362 under 26, but only 63 of 45 years and upwards; and for every 100 female slaves of 26 and under 45, there were 345 under 26 years of age, and 46 of 45 years and upwards.

These interesting results will be more clearly perceived in the following Table:

Class of Persons.	Under 20.	Of 26, and under 45.	Of 45, and upwards.
Males, Free, -	354	100	65
Males, Slaves,	334	100	47
Females, Free,	362	100	63
Females, Slaves,	345	100	46

These numerical results clearly prove the baneful effects of hard labour and coercion on the unfortunate slaves; and is most manifest in the class of 45 and upwards, the representative numbers for the male and female slaves being so very much below the corresponding numbers for the free population. If we admit, however, for a moment, that the relation of the representative numbers of the male and female slaves, to the corresponding numbers of the free white population, be such as the laws of nature allow; and that slavery exerts no improper influence on the condition of man, then ought the representative numbers belonging to the classes under 26, and of 45 and upwards, in the free persons and slaves, to bear some analogy to each other. This, unfortunately for the interests of humanity, is not the case; for if we take the males of the classes here alluded to, we shall find, that if the slaves of 45 and upwards bore the same relation to the free males of that age, as the slaves under 26 do to the free males of the same class; then, instead of there being only 47 for the representative number of the oldest class of slaves, there should have been 61; and if a similar comparison be made for the females, we shall find, that, instead of the representative number for the oldest class being 45, it should have been 60. Hence it appears there is a deficiency of no less than 14 persons of each sex, in relation to the assumed number for the class of 26 and under 45, *occasioned, it may be fairly said, by the hard labour, and the many miseries necessarily attendant on slavery.* This is a point of view, however, much too favourable, for, considering the subject, no other reason can be assigned, why the representative numbers for the slaves under 26 are also *below* the corresponding numbers for the free persons, but that the effects of slavery have made them

so. There cannot be so essential a difference in the natural constitutions of the slaves and free persons, as to create so decided a change among the representative numbers as the Table presents. The diversities must be the result of the circumstances of each.

It is most remarkable, however, that a kind of analogy should run through the several representative numbers of the same class. For example, if we take the class under 26, we shall find the female slaves nearly a fourth proportional to the free males, the male slaves, and the free females; for 354 : 334 : : 362 : 342, agreeing within three persons of the representative number for the female slaves. The same principle will also be found to agree still more closely with the last class; for 65 : 47 : : 63 : 46 nearly. Now, the proportionality of these numbers proves, that whatever may be the nature of the causes which operate on the slave population, their influence on both the sexes must be very nearly the same. But are those causes favourable to the happiness and well-being of the slaves? Are they such as to leave them no room to regret their condition, when they contrast it with the situation of the free population which surrounds them? These are questions most interesting to the philanthropist, and to the satisfactory solution of which, every friend of humanity is desirous of lending his aid, however feeble and weak it may be. It would indeed communicate a pleasure of no ordinary kind, if it could be satisfactorily proved, that the causes so operating are not such as are hostile to human happiness, to the well-being and moral improvement of this unfortunate people. But the reverse is much to be feared.

The male slaves under 14 years of age, in each individual State and territory, exceed the females of the same age in number; and if we take the average of the whole slave population, the relation will be found to be about that of 106 to 100. But for the other classes, the preponderance will be found, in some of the States, on the side of the males, and in others on that of the females. Taking, however, the aggregate amount of each class, for all the States, the males will be found to exceed the females for all ages; though in the class from 14 to 26 they approach exceedingly near to an equality. The results of these comparisons may be arranged in a Table, and which will at

once exhibit the relation between the males and females of each class:

Ages.	Proportional number of Males.	Proportional number of Females.
Under fourteen, - -	106	100
Fourteen, and under twenty-six,	100	100
Twenty-six, and under forty-five,	107	100
Forty-five and upwards, -	110	100

It therefore appears, that, in the transition from the first class to the second, of the slave population, the ratio of majority which at first existed, becomes gradually converted into one of equality; but that, from this latter class to the final one, the ratio again augments, and attains its maximum during the decline and close of life.

The results which the above Table affords, are so very different from those which have been obtained from the returns of the free coloured persons, that no apology may be necessary for somewhat interrupting the order of the essay, by introducing them in this place:

Ages.	Proportional number of Males.	Proportional number of Females.
Under fourteen, - -	104	100
Fourteen, and under twenty-six,	84	100
Twenty-six, and under forty-five,	86	100
Forty-five and upwards, -	93	100

How opposite must have been the causes which contributed to produce the first numerical columns of the preceding Tables! They are most unquestionably of a highly interesting nature, and deserving, in a particular degree, the attention of the philosopher. One principle may be clearly deduced from them, that the condition of the female is much improved by the blessings of freedom; but how far the representative numbers for the males may be safely compared with each other, considering the probability there is, that this class of the slave population is continually receiving augmentations of an irregular kind, through the various channels which unfortunately exist for the

supply of slaves, is a subject worthy of much consideration. From whatever causes, however, the differences among the representative numbers may arise, their remarkable disparity renders it a question of peculiar interest, and worthy of a distinct examination.

For the purpose of estimating the rates according to which the slaves have either increased or decreased, in the several States and territories, the following table has been computed from the respective population returns:

	States & Territories.	Rates of Increase or Decrease from 1790 to 1800.	Rates of Increase or Decrease from 1800 to 1810.	Rates of Increase or Decrease from 1810 to 1820.
North: States.	Maine.			
	New Hampshire,	— 94.9		
	Massachusetts,			
	Rhode Island,	— 60.0	— 71.6	— 58.3
	Connecticut,	— 65.6	— 67.4	— 68.7
	Vermont,			
Middle States.	New-York,	— 3.4	— 37.3	— 32.8
	New Jersey,	+ 8.7	— 14.5	— 30.4
	Pennsylvania,	— 54.3	— 114.6	— 73.5
	Delaware,	— 44.4	— 47.3	+ 7.9
	Ohio.			
	Indiana,			— 19.8
Southern States.	Maryland.	+ 5.4	+ 2.7	— 3.8
	Virginia,	+ 18.2	+ 13.5	+ 8.3
	North Carolina,	+ 32.5	+ 26.7	+ 21.5
	South Carolina,	+ 36.5	+ 34.4	+ 28.2
	Georgia,	+ 138.2	+ 76.2	+ 42.2
	Louisiana,			+ 2193.7
	Tennessee,		227.8	+ 79.9
	Kentucky,	+ 224.6	+ 99.7	+ 57.3
Territories.	Alabama,			+ 20.8
	Missisippi,		+ 389.8	+ 92.0
	Illinois,			+ 445.8
	Missouri.			
	Michigan.			
	Arkansas.			
	Columbia,		+ 360.3	+ 18.2
	The entire Slave population,	+ 28.2	+ 33.2	+ 29.1

With reference to the above table, it may be observed, that, in the districts of Maine and Massachusets, no slaves have been recorded in any of the returns; and it may hence be presumed that these districts have been always free from this class of persons. In the census of 1820, the following States, in addition

to those last mentioned, were found without slaves, viz. New Hampshire, Vermont, Ohio, and the territory of Michigan; their numbers having rapidly decreased from one census to the other, so as in the last enumeration to have disappeared altogether. In New Hampshire, for example, the decrement from 1790 to 1800 was 94.9 per cent.; and this diminution having been probably continued with still greater rapidity, during the succeeding periods, the whole slave population had vanished before the enumeration of 1810; nor were any traces of their existence to be found in 1820. In Rhode Island, the decrements will be perceived to be rapid and continuous, during the whole period embraced by the table; and, in the last census, the slaves were found to amount only to 45 in number, and these will most probably disappear before the next census of the people.

In Connecticut, the decrements have been increasing through each period, leaving, in 1820, only 97 slaves. In Vermont, in the year 1790, only 16 slaves were to be found, but not one in the succeeding census. In the State of New-York, the slaves, in 1790, amounted to above 21,000. In the succeeding ten years they received a feeble decrement of 3.4 per cent.; but, in the following period, it amounted to 37.3 per cent.; and in the decade from 1810 to 1820, the rate of decrease was continued at the rate of 32.8 per cent.; leaving, at the end of the period last mentioned, only 10,088 slaves; so that the time may not be far distant, when the inhabitants of this large and populous province will have to boast that every native of its soil is free.

In the first of the periods included in this table, New Jersey received an increment of 8.7 per cent. to its slaves; but, in the succeeding period, a decrement of a greater magnitude was found; and, during the last period, this decrease became still greater, amounting to 30.4 per cent., leaving only 7557 slaves at the last census. In Pennsylvania, the slaves have declined very considerably since 1790, having diminished, in the first interval, 54.3 per cent.; in the second, 114.6 per cent.; and, in the third, 73.5 per cent.; so that the slaves which, in 1790, amounted to nearly 4000, were reduced, in 1820, to a little more than 200. Delaware, on the contrary, which had received considerable decrements in the first and second periods, in

the last received a small increment; its slave population, according to the last census, exceeding 4500. Maryland also, which, during the first and second periods, had received increments respectively proportional to 5.4 and 2.7, in the last period experienced a decrement of 3.8 per cent. But any increment, however small it may be, when operating on a considerable slave population, like that contained in Maryland, must be viewed with concern. In 1790 the slaves amounted to above 103,000, and these, by the increments they received in the succeeding decades, were increased, in 1810, to more than 111,000; but the decrements experienced in the last period reduced them to about 107,000. In Virginia, also, with slaves amounting, in 1790, to nearly 293,000, we cannot but contemplate with pain so large an increment as 18.2 per cent. in the first period, 13.5 per cent. in the second, and 8.3 in the third; and though these increments form a descending series, still operating, as they do, on so large a population, the effects must be very considerable; and hence we find, that, in 1820, the slaves amounted to above 425,000, making an increase, in thirty years, of 132,000. Should these increments, during succeeding years, still diminish, we may hope to see the slave population of Virginia reduced to a stationary state; or, what would be still more pleasing to contemplate prospectively, such a series of decrements, as would speedily lead to a total removal of this unfortunate order of men. The two Carolinas also have received increments during each period, but of a decreasing kind. In the northern province of this name, the increments were respectively as 32.5, 26.7, and 21.5, during the three periods indicated in the table; and, in South Carolina, as 36.5, 34.4, and 28.2; these increments, augmenting the slave population of the former province, in thirty years, from 100,000 to 169,000 nearly; and, in the latter, from 107,000 to 250,000 nearly. Georgia, in 1790, had a slave population of above 29,000; during the succeeding ten years it received an increment of 138.2 per cent.; and, in the period from 1800 to 1810, another increment of 76.2 per cent.; and, in the last decade, a still farther increase of 42.2 per cent. The consequence of these rapid increments has been, to increase the slave population from a little more than 29,000, to nearly 150,000, during the space of thirty

years. But the most considerable increment in the whole of the States and territories, is that which the province of Louisiana received in the period from 1810 to 1820, amounting to 2193.7 per cent. This immense rate of increase in the slave population, very much exceeds the increment of the whole population, and proves that the slaves have increased in a much more rapid ratio than the other branches of the population. This has arisen most probably from the circumstance, that the free settlers, who may have migrated to this territory, carried with them numerous slaves. The number of slaves, in 1810, amounted only to 3011; whereas, in 1820, they had increased to 69,064. During the same interval, the free branches of the population increased from 17,834 to 56,715. In the year 1810, the slaves were to the free population as 23 to 138; but, in 1820, they were as 23 to 28;—a change most melancholy for the friends of humanity to contemplate, and most striking, when contrasted with the results obtained from other territories. From Indiana, for example, where in 1810 there were 103 free persons for every slave, and in the last census no less than 773; the slaves having *decreased* 19.8 per cent., and the free branches of the population *increased* 505 per cent. The state of Tennessee, also, received a large increment to its slave population, amounting to 227.8 per cent., in the decade from 1800 to 1810; and, in the succeeding period, another increment of 79.9;—the two increments having increased the slaves from 13,584, their number in 1800, to 80,107, their amount in 1820. In Kentucky, in the year 1790, the slaves amounted to 12,430; but an increment of 224.6 per cent. received during the first decade; another increment of 99.7 per cent. during the second; and of 57.3 in the third period, augmented the slaves, from the number before mentioned, to 126,732, their amount in 1820. Only two enumerations of Alabama have taken place, viz. in 1810 and 1820; and, from a comparison of these, it appears, that the slaves increased during the ten years at the rate of 20.8 per cent. At the last enumeration they amounted to nearly 42,000. In the period from 1800 to 1810, the territory of Missisippi received an increment of 389.8 per cent.; and this was succeeded by another of 92 per cent.; the two increments having augmented the slaves from 3,489 to 32,814, their amount in 1820. In Illinois,

the increment during the period from 1810 to 1820 amounted to 445.8 per cent.; but this large rate of increase fortunately operated only on a small population. The slaves, however, increased more rapidly than the free persons; for, in 1810, the slaves were to the free persons as 1 to 72; but, in 1820, as 1 to 59. In 1820 the slaves in the territory of Missouri amounted to 9722; but as this was the first enumeration, no rate of increase can be assigned. The same remark applies also to Arkansas, the slaves in that territory amounting, in 1820, to 1617 persons. In Columbia, the increment from 1800 to 1810 was great, amounting to 360.3 per cent.; but which was most strikingly reduced in the next decade to 18.2 per cent. In 1820 the slaves amounted to 6377.

On reviewing the changes which the numerical results of the slave population have undergone, during the periods embraced by the foregoing table, some of them are perceived to be distinguished by increments, and others by decrements; and it therefore may not be uninteresting to enquire in what way these opposite results are connected with the four great divisions into which the American States have been latterly divided. The Northern States, it will be perceived, are either altogether without slaves, or the changes which their numbers have undergone, during the thirty years ending in 1820, have been all of a decreasing kind; the whole of their numerical rates falling under the class of *decrements*. The same remark will also apply to the middle States, with the single exception of a small increment to the State of New Jersey, in the first period; and of a nearly similar increment to Delaware, in the last. But in the Southern States, the changes have been all of an *increasing kind*, excepting a small decrement received by Maryland in the last decade; and hence, with this single exception, all the numerical results fall under the class of *increments*. And it is to be regretted that these increments should have operated on by far the largest portion of the slave population in the United States; and that, therefore, as a necessary consequence, the increase of the slaves must have been very considerable. The changes also in the slave population of the territorial governments are of the same kind as those in the Southern States.

It hence appears that the numerical changes which the slaves have undergone are of two opposite kinds; and that, therefore,

the United States and territories may be properly separated into two great divisions,—*the* DECREMENTS *being confined to the Northern and Middle States, and the* INCREMENTS *to the Southern States, and territorial governments.* In 1820, the slaves in the former States amounted to 22,697, and the free white population to 5,138,303; so that *for every slave there were 226 free persons.* But in the same year, the slaves in the Southern States and territorial governments amounted to 1,508,747 persons, and the free white population to 2,955,987, *scarcely affording for every slave two free persons.* The philanthropist can scarcely contemplate a more melancholy contrast than this. It would be uncandid perhaps to say, that, in contrasting the Northern and Middle States with the southern provinces and territorial governments, that the degrees in which humanity, and the graces of Christian charity, prevail, bear any proper relation to the striking results which this comparison affords;—still, it exhibits a humiliating picture of the latter provinces, when we contemplate, that, *out of every three persons, in their vast population, one of them is a slave;* and this in a country also, which, as far as its white population is concerned, has good reason to boast of its liberty, and of all the substantial blessings which arise from the utmost limits of religious and political freedom. In some of these States, indeed, as the succeeding table will more particularly display, the slaves will be found to bear a still higher relation to the white population than that above alluded to. In Virginia, in South Carolina, in Georgia, and in Missisippi, among every twelve persons seven of them will be slaves; and yet the soil of these provinces affords an easier support to their inhabitants, than the stubborn lands of Pennsylvania. In the latter state, the ground requires deep and repeated ploughing to render it fruitful; but in the former provinces, merely "scratching" it once or twice affords tolerable crops *.

It would be interesting, also, if we possessed the requisite materials, to attempt a moral estimate of the habits and characters of the inhabitants of these two great divisions of the American States. That there is room for supposing some difference to exist, may be inferred from a remark made by Dr Rush, in the

* See account of the progress of population, agriculture, manners, and government, in Pennsylvania, by Benjamin Rush, M.D., vol. iii. p. 183, of the Manchester Transactions.

paper just quoted, viz. "that our State (Pennsylvania), is the great outport of the United States for Europeans; and that, after performing the office of a *sieve, by detaining all those people who possess the stamina of industry and virtue, it allows a passage to the rest to those States which are accommodated to their habits of indolence and vice.*" The States particularly mentioned by Dr Rush, are Virginia, North and South Carolina, and Georgia. Whether, however, the character which he attributed to them in 1786, be not too strongly marked for the present period, and whether the white inhabitants of those States may not have improved in their moral habits, in common with the age, is a question worthy of the most deliberate consideration. Still, in the most favourable point of view in which the subject can be contemplated, there is much reason to fear that the solid attributes of virtue cannot be very powerfully developed in a being, who is surrounded on all sides by slaves, and who can draw no other impression from their low and unhappy condition, but such as have a tendency to debase the mind. No associations can arise from the contemplation of a social system of this kind, if social it may be called, all calculated to exalt the human character, to develope the pure feelings of humanity, and unfold all the better attributes of our nature. The time, however, may come, when the American Government will feel disposed to give a practical proof of its love of liberty, by extending the blessings of freedom to her slave population. And, in the mean time, much may be done in all the States, but particularly in the southern and territorial governments, to check, by every humane and laudable means, their farther increase; to soften and improve the condition of these who remain; and, by freeing their minds gradually from the degrading fetters of ignorance, as well as their bodies from the dominion of the chain and the whip, to prepare them for all the blessings of a final emancipation, and to which, as moral and intelligent beings, *they are equally entitled with themselves.*

It may not, however, be uninteresting, to pursue this branch of the subject a little farther, and to trace, in a more particular manner, the numerical relations existing between the slaves and the free population, in all the States. For this purpose, the following table has been calculated, and which, by assuming unity as the representative number for the slaves in each State, ex-

hibits, in its proper columns, the free persons proportional to it. It may be necessary to observe, that when the character ∞ occurs in the table, it is intended to express, that no slaves existed in the State or the territory at the time of the enumeration;—and, that when the symbol * occurs, no enumeration was taken, either of slaves or free persons.

	States and Territories.		Free Persons in 1790.	Free Persons in 1800.	Free Persons in 1810.	Free Persons in 1820.
North. States.	Maine,	One Slave to	∞	∞	∞	∞
	New Hampshire,		897	22981	∞	∞
	Massachusets,		∞	∞	∞	∞
	Rhode Island,		72	181	711	1851
	Connecticut,		85	263	844	2836
	Vermont,		5315	∞	∞	∞
Middle States.	New-York,		15	27	63	135
	New Jersey,		15	16	22	36
	Pennsylvania,		115	352	1016	4972
	Delaware,		6	9	16	15
	Ohio,		9	∞	∞	∞
	Indiana,		*	41	102	774
Southern States.	Maryland,		2.1	2.3	2.4	2.8
	Virginia,		1.6	1.5	1.5	1.5
	North Carolina,		2.9	2.6	2.3	2.1
	South Carolina,		1.3	1.4	1.1	0.9
	Georgia,		1.8	1.7	1.4	1.3
	Louisiana,		*	*	6	1.2
	Tennessee,		*	7	5	4.3
	Kentucky,		5	4.5	4	3.5
Territories.	Alabama,		*	*	1.2	3.0
	Missisipi,		*	1.5	1.4	1.3
	Illinois,		*	*	72	59
	Missouri,		*	*	*	5.8
	Michigan,		*	*	197	∞
	Arkansas,		*	*	*	8
	Columbia,		*	4	3.4	4
	The whole Population,		4.6	4.9	5.1	5.3

This table brings into one point of view the relation which existed between the slaves and the free white persons in every State, and also with the aggregate population, at the periods indicated at the heads of the respective columns. In the Northern and Middle States, the numbers will be found to increase in all the periods, excepting in the single instance of Delaware, in the year 1820; but, in the Southern States and territories, they will be found, on the contrary, generally to decrease; confirming the remark before made, that, in the former provinces, the slaves

have diminished,—but in the latter generally increased. Many facts of a very interesting nature may be drawn from this table. It is curious, for example, to observe, how, in some of the States, the representative numbers for the free population augment, and become, in succeeding periods, denoted by ∞ ; proving the slaves to have vanished ;—and how, in other cases, that a close equality should exist, between the relations of the slaves to the free persons, at different periods ;—that, although the former may have been augmented by increments of a very irregular kind, the free population should still maintain an uniform relation to them. The most striking example of this nature, is in the state of Virginia, where the representative numbers for the years 1800, 1810, and 1820, are each 1.5 ; notwithstanding both the increments of the free population and the slaves, in the different periods, were of a very unequal kind. The irregularities, therefore, in the increments of the slaves, must have been compensated by increments of a corresponding kind, in the free white population. In other instances, the results present examples of numbers, forming arithmetical progressions. Kentucky and Missisippi present perfect cases of the kind, through the entire range of their numerical results, and North Carolina very nearly so ; although the increments which their free white and slave populations received, during the corresponding periods, bear no visible relations to them. These singular relations, together with the corresponding results of the whole population, are arranged in the following Table :

Date.	Kentucky.			Missisippi.			North Carolina.			Entire Population.		
	Relation of Slaves to Fr. Persons.	Increments to Free Persons.	Increments to Slaves.	Relation of Slaves to Fr. Persons.	Increments to Free Persons.	Increments to Slaves.	Relation of Slaves to Fr. Persons.	Increments to Free Persons.	Increments to Slaves.	Relation of Slaves to Fr. Persons.	Increments to Free Persons.	Increments to Slaves.
1790	One Slave to 5.0			One Slave to *			One Slave to 2.9			One Slave to 4.6		
1800	4.5	199.9	224.6	1.5	*	*	2.6	21.4	32.5	4.9	35.1	28.2
1810	4.0	83.9	99.7	1.4	35.6	389.8	2.3	16.2	26.7	5.1	36.1	83.2
1820	3.5	38.8	57.3	1.5	87.0	92.0	2.1	15.0	21.5	5.3	32.9	29.1

It is very pleasing to observe, with respect to the entire population, that the free persons have increased in a greater ratio than the slaves, through the whole of the period, since the first authorised census. This conclusion may be inferred from one

of the last columns of the preceding table, and as the fact is worthy of being particularly remembered, it may be more explicitly stated as follows:

In 1790,	the relation of the Slaves to the Free Persons, were as	10 to 46
In 1800,		10 to 49
In 1810,		10 to 51
In 1820,		10 to 53

Many other interesting relations might possibly be deduced from the tables relating to the slave population; but it is time to hasten to the consideration of the facts which this survey of the American population has afforded, relative to the numbers devoted to agriculture, commerce, and manufactures *.

* In Counsellor Cooper's Letters on the Slave Trade, it is remarked, "that the proportion of deaths among slaves has been determined, from a series of observations, to be about 1 in 20." Adopting this, therefore, as the most probable datum to which we can at present refer, we may determine from it what proportion of births is necessary, in order to produce the slave population, at the different periods referred to. For this purpose, let A denote the amount of the slave population, at any given period, A′ its amount at any succeeding time, and n the interval in years. Let also $\frac{1}{m}$ represent the rate of mortality, and $\frac{1}{x}$ the annual ratio of births; then, from the formula of population,

$$A' = A\left(1 + \frac{m - x}{mx}\right)^n,$$

we may deduce, by the application of logarithms,

$$\log\left(1 + \frac{m - x}{mx}\right) = \frac{\log A' - \log A}{n},$$

the latter number of which, being a known function, may be denoted by log O; hence, the preceding equation will become,

$$\log\left(1 + \frac{m - x}{mx}\right) = \log O;$$

and, by passing from logarithms to numbers, there will arise,

$$1 + \frac{m - x}{mx} = O;$$

and which, by reduction, produces

$$x = \frac{m}{m(O - 1) + 1},$$

a general formula for the annual ratio of births.

From the actual enumerations of the slaves, we deduce the following results:

For the period from	1790 to 1800,	the value of O is	1.0254
	1800 to 1810,		1.0291
	1810 to 1820,		1.0259,

and which values of O, being substituted in the preceding formula, and also the value of m (20), there will arise the following values of x; viz.

From

On Agriculture, Commerce, and Manufactures.

The columns devoted to these occupations, in the census for 1820, enable us to make an estimate of the degrees in which they severally prevailed, in the different provinces of the United States; and, if necessary, by reducing the population to the same radix, to compare them with similar employments in other countries. Surveys of this nature, carried on at regular periods, and performed with accuracy and care, become in time the fruitful sources of much valuable information. By them the growth of

---

From $\left\{\begin{array}{l}\text{1790 to 1800,}\\ \text{1800 to 1810,}\\ \text{1810 to 1820.}\end{array}\right\}$ the value of x is $\left\{\begin{array}{l}13.3\\ 12.6\\ 13.2,\end{array}\right\}$ affording for the annual proportion of births, $\left\{\begin{array}{l}\frac{1}{13.3}\\ \frac{1}{12.6}\\ \frac{1}{13.2}\end{array}\right.$

The average of these ratios is $\frac{1}{13}$th.

If we admit, with Mr Cooper, that the fraction $\frac{1}{20}$th, is a proper representative of the rate of mortality, we may be disposed to consider the annual proportion of births here deduced as too great; and that it affords the probability, that, in each of the periods above mentioned, *considerable importations of slaves must have taken place.* It would be possible, indeed, to introduce an element, corresponding to the average annual import of slaves, into a formula combining the elements of birth and mortality, and hence to form something like an estimate of the annual number actually imported. To accomplish this, it may, in the first place, be remarked, that, whether the births exceed the deaths, or the contrary, the *difference* of the fractions which denote them, must always be some determinate function of the actual population, and hence may be denoted by $\pm\frac{1}{\pi}$. If we also adopt y for the average annual import of slaves, and w as the representative of $1\pm\frac{1}{\pi}$, the amount of the slave population, after n years, will furnish the equation

$$\begin{aligned} A' &= y\,w + y\,w^2 + y\,w^3 \ldots\ldots\ldots + y\,w^n \\ &= y\,(w + w^2 + w^3 \ldots\ldots\ldots + w^n) \\ &= \frac{y\,w\,(w^n - 1)}{w - 1}, \end{aligned}$$

and from which we deduce

$$y = \frac{A'\,(w-1)}{(w^n - 1)},$$

a general expression for the average annual import of slaves, in terms of their *present* number, and their average annual rates of *births* and *deaths*. All of these elements are such as a perfect table of statistics ought to furnish.

agriculture may be traced, and the steps which mark its decline, either in the individual provinces of a state, or in the aggregate of a country at large, may be readily and satisfactorily measured. So, also, the dawn of trade, and its gradual enlargement;—the feeble beginnings of the arts, and their rapid progression, when quickened by the active springs of commercial enterprise and speculation,—all have an influence on population; and their proportional effects become manifest, by accurate periodical returns. In some divisions of a country, for example, agriculture may advance with rapidity, and make the steps, by which commerce ascends, appear feeble and unimportant. In other States, commerce and manufactures may exhibit strong proofs of maturity and vigour, but the arts connected with agriculture display every symptom of languor and decay. These varied changes, with many other mutations of a smaller kind, may be satisfactorily estimated, when statistical surveys are well conducted, and all the elements necessary for undertakings of the kind are faithfully and properly introduced.

To estimate, in a satisfactory manner, the various degrees in which agriculture, commerce, and manufactures prevail, in the different provinces of the United States, the following table has been computed, from the population returns for 1820, by making the number of persons in each of the classes here alluded to, proportional to a population of 10,000 persons; and to render the comparison convenient, the numerical results have been arranged in descending series, with the name of each state opposite to its appropriate representative number.

Proportion of Ten Thousand Persons chiefly employed in

Agriculture,		Commerce,		Manufactures.	
Indiana, -	4166	Michigan, -	441	Rhode Island,	733
Louisiana,	3516	Louisiana, -	407	Columbia, -	661
South Carolina,	3295	Massachusetts,	254	Massachusetts,	639
Georgia, -	2967	Columbia, -	155	Connecticut,	637
Missisippi, -	2920	Maine, -	144	New Jersey, -	574
North Carolina,	2727	Rhode Island,	140	Pennsylvania,	574
Virginia, -	2595	Connecticut, -	130	Maryland, -	458
Arkansas, -	2531	Maryland, -	117	New-York, -	437
Tennessee, -	2415	Missouri, -	75	Louisiana, -	394
Alabama, -	2396	Delaware, -	73	Delaware, -	388
Kentucky, -	2342	Pennsylvania, -	67	Vermont, -	360
Illinois, -	2245	New-York, -	66	New Hampshire,	356

Table continued.

Proportion of Ten Thousand Persons chiefly employed in					
AGRICULTURE,		COMMERCE,		MANUFACTURES.	
Vermont, -	2161	New Jersey, -	66	Ohio, -	320
New Hampshire.	2145	Georgia, -	63	Virginia, -	304
Missouri, -	2140	Arkansas, -	55	Missouri, -	293
Maryland, -	1943	South Carolina,	53	Maine, -	256
Ohio, -	1909	New Hampshire,	44	Michigan, -	220
Maine, -	1844	Virginia, -	42	Indiana, -	219
Connecticut,	1835	Illinois, -	42	Kentucky, -	209
Delaware, -	1823	North Carolina,	40	Tennessee, -	186
New-York, -	1804	Missisippi, -	39	North Carolina,	185
Michigan, -	1650	Alabama, -	35	Illinois, -	182
Rhode Island,	1512	Vermont, -	33	South Carolina,	132
New Jersey, -	1470	Kentucky, -	29	Arkansas, -	125
Pennsylvania,	1342	Indiana, -	29	Alabama, -	110
Massachusetts,	1213	Ohio, -	25	Georgia, -	104
Columbia, -	258	Tennessee, -	21	Missisippi, -	86
The whole population,	2146	The whole population,	75	The whole population,	363

At the summit of the agricultural column will be found Indiana, and at the bottom of the same Columbia; because, in the former state, agriculture abounds in a maximum degree, in proportion to its population; and in the latter, the least of the whole series. In the first line also of the commercial column will be found Michigan, and in the last Tennessee; and in the column for manufactures Rhode Island appears to enjoy their advantage the most, and Missisippi the least. The order in which the provinces are arranged, in conformity to the value of the representative numbers, although a little at variance with their geographical positions, will not only enable us to trace with ease the gradations in the influence of those arts, subservient to the existence and well-being of man, through all the different States, but likewise, if necessary, to ascertain the comparative relations and importance of agriculture, commerce, and manufactures in each State; and also, in the great mass of the provinces at large. If we wish, for example, to compare the condition of agriculture in Kentucky with that of Maryland, we shall find, that they are to each other as 2342 to 1943; or that this necessary art prevails in the former State above the latter, in nearly the ratio of 23 to 19. In like manner, if it be required to compare the commerce of New York with that of New Jersey, we shall find, that because each is denoted by 66, they are in a ratio of

2

equality; that is, that in proportion to the respective population of these States, commerce prevails in the same degree. So, also, if we feel desirous of contrasting the degrees in which agriculture, commerce and manufactures prevail in South Carolina, we shall find they are to each other as follows, viz.

Agriculture,	3295	or nearly as	124
Commerce,	53		2
Manufactures,	132		

We further perceive, that ten of the representative numbers of the agricultural column are greater than 2146, the number deduced from a comparison of the total agricultural population, to the whole population of the country; and also that 8 of the numbers in the commercial column, and 10 in that devoted to manufactures, respectively exceed the numbers 75 and 363, being those which exhibit the relation of the aggregate of each of these occupations, to the whole population. In like manner, we find, that the agriculture of New Hampshire, the commerce of Missouri, and the manufactures of Vermont, approach, in the nearest degree, to the numbers here alluded to. By a farther inspection of the table, it likewise appears, that agriculture exceeds commerce in a maximum degree, in Indiana, and in a minimum degree, in the territory of Michigan; that it also exceeds manufactures in the greatest degree in Missisippi; but that in the district of Columbia, the representative number for agriculture will be found much inferior to that of manufactures.

The decided superiority of agriculture, in all the States, above their commerce and manufactures, gives room for many striking reflections, respecting the almost unbounded capabilities of the country;—of the influence which a plentiful supply of the means of subsistence must necessarily have,—in accelerating the population,—in improving their political condition, and giving a high tone to their moral character; and, in conjunction with that active spirit, which will most probably stimulate their commerce and manufactures for a long succession of ages, must open to the inhabitants of the great northern division of the new world, treasures of a nobler kind than those afforded by the mines of Peru.

PLYMOUTH,
February 21. 1823.

ART. IX.—*Journal of a Tour to the Coast of the Adriatic Sea, and to the Mountains of Carniola, Carinthia, Tyrol, Saltzburg, and Bohemia, undertaken chiefly with a view to the Botany and Entomology of those countries.* By Dr DAVID HENRY HOPPE and Dr HENRY HORNSCHUCH. (Continued from vol. viii. page 326).

" *Hundsberg, March 22.*—MANY of the plants which we have collected on our journey, require to be put into the press to dry. Amongst them are several mosses from Pirano. It is an excellent thing for botanists, that these plants can be kept for a long time in a fresh state; and it may be generally remarked, that if they do not lose their calyptra and lid, they do not suffer. In the afternoon we went into the city, that we might give our friends a proof of our safe return.

" *Hundsberg, March 23.*—In order to repair the time that we had lost, we must, this day, make a botanical excursion. We have therefore fixed upon visiting Contobello, to seek for the *Euphorbia Characias*, which we did not find in flower on the 1st of March. We had intended being there on the 15th; at which period, according to our calculations, the plants would first be in blossom. The journey to Venice prevented our putting this plan in execution; but we found that we were, even now, quite soon enough. Vegetation is, however, somewhat advanced, and the Karsch (coarse stony ground, so called) appears disposed to exchange his grey winter garb for a green summer one. The almond, peach and cherry trees, and perennial plants are shooting forth their leaves; amongst the latter we recognised *Salvia officinalis* and *Teucrium flavum* in leaf, where they been protected from the cold, by rocks, in the wood of Contobello. We descended through the vineyard to the coast, to collect marine plants; but this was attended with difficulty. The sea ran high, and we were obliged to take off the lower part of our dress; by which means we got our feet bloody from the sharp stones of the shore. But nothing can be accomplished without labour. We found a large heap of *Cardium rusticum*, which had probably been thrown from the net of a fisherman, as the animals were all dead. We

picked out the finest coloured shells, and carried home our handkerchiefs full of them."

"*Hundsberg, March 25.—Covetousness is the root of all evil.*—Yesterday, and part of to-day, were wholly occupied in laying out the plants previously collected; but having completed this task about noon, one of us proposed employing the afternoon in going abroad, to search for plants of *Primula acaulis*, of which we had, a few days ago, seen specimens in an orchard between this place and Trieste. The garden-wall which bordered the footpath was low, and here and there broken down, where reparations were about to be made, so that we easily obtained entrance, and got half way down the declivity of the hill where the *Primula* grew. The finest plants were soon selected, dug up, and carried to the vasculum, which was presently filled. The farther, however, we searched among the trees and bushes, the larger did the specimens appear; and we also found a variety with white flowers. But when these were to have been conveyed to the box, behold, it was gone! A cunning Italian had, perhaps, been looking for some while from above, at the careless botanist, and formed the scheme of stealing his box, in which, alas! he too well succeeded. The rascal had also carried away with it our beautiful primroses. The loss of the box is, indeed, of no small consequence to us; as we must, of necessity, get a new one made, which is attended both with expence, and loss of time. However, we resolved not to distress ourselves too much on account of this mischance, the first that in our whole journey we have met with; and spent the evening, accordingly, over a bottle of Proseko, to our favourite sentiment, "*Let nothing trouble thee!*"

"*Hundsberg, March 27.—The Scorpion Excursion.*—The violent wind of yesterday obliged us to remain within doors. To-day we went out to the southward early in the morning, and proceeded to the top of the hill of *Hundsberg*; in ascending which, we saw, under the brushwood, little besides *Helleborus viridis* and *Primula acaulis*. *Carex collina* of Willdenow, and *C. præcox* of Jacquin began to shew their male spikes, and *Scilla bifolia*, and *Hyacinthus botryoides*, with *Erica herbacea*, were in blossom.

"As *Flora* seemed to refuse to pour down plenty upon us from her *cornucopia*, we determined to try our success with *Fauna*. Accordingly, we turned over a couple of hundred stones, and tried what could be done in the way of entomology. At first we found nothing but *Scorpions*, and therefore determined to name the excursion of this day in honour of them. Heaven, however, has blessed this country with other insects; for we presently took two new *Chrysomelæ*, an unknown *Melolontha*, and some small *Carabi*; as also the *elytræ* (or wing cases) of *Cetonia fastuosa*. Specimens of *Geotupes nasicornis*, and *Cerambyx Heros*, having been brought to us, we hoped to find these also; a circumstance that appeared the more probable, as the whole mountain is covered with low oaks; and the people frequently related to us how they are bitten by insects, that are found here in the summer. Flora now, perhaps, became jealous of us; for in our way to the other side of the mountain, our attention was attracted by a *Syngenesian* plant, that appeared to us new. We had seen it indeed at Friaul, but in an imperfect state.

"We passed over another similar hill, then went through several vineyards, crossed the road to Fiume, left Sarvolo on the left hand, and turned towards the sea-shore. Here we got *Ulva intestinalis*, with many other marine plants and shells; but as the wind continued to blow strong, we hastened home.

"*Hundsberg, March 28.*—We have fully employed this day in the preservation of our insects, in laying out our plants, and cleaning our shells. We then examined our novelties.

"We have given the name of *Leontodon taraxacoides* to our new plant, and established the following character: "Calyce exteriore erecto, squamis ovato-lanceolatis, foliis runcinato-pinnatifidis, laciniis reflexis acutis integerrimis, scapo glabro unifloro, superiore attenuato *. Hab. in collibus graminosis littoralibus. Floret Martio.

"It is more than probable that this species has been formerly seen, but passed, by other botanists, under the idea, that it was either *Leontodon Taraxacum*, or *L. salinum*. It differs, however, in many respects, from either of these, and forms an in-

* This species has since been well figured in Sturm's *Deutschland Flora*, No. 41.

termediate species. In order that other naturalists may form their opinion respecting it, from authentic specimens, we have determined upon preserving a large number of these. We shall do the same with any other plants that we shall think require to be particularly studied; and at the close of our journey, shall compare them with the valuable books and collections of Count Von Sternberg, when we shall be able to speak with more confidence respecting them."

"*Hundsberg, March* 29.—We intended, very early this morning, to have collected some more specimens of our *Dandelion;* but we had forgotten to consult the Linnean *Horologium Floræ*, and were too soon; the sun was still behind the mountains, and our new *Syngenesian* in a deep sleep. We were therefore obliged to return at a later hour. Half the day was employed in preparing and laying out marine plants. In the afternoon we went into the city, to purchase some articles necessary for preserving plants and insects, as we had consumed our whole stock. We found in the coffee-house *della Stella polaris*, the German Correspondent, with the information, that the plague had broken out in the suburbs of Fiume; which is a subject of great consideration for us, as we are only a good day's walk from the Hundsberg to Fiume, and soon intend to walk there. Such being the case, we shall be obliged to fill our brandy bottle with *Acetum prophylacticum*.

"We passed some pleasant hours in the evening with our friends Geropp and Brandentberg, and had some excellent Rhenish wine. Foreigners cannot praise the wine of this country; but in a sea-port you may procure almost every thing."

"*Hundsberg, March* 31.—We were obliged to keep at home both yesterday and to-day, in order to make preparations for our excursions of the approaching month.

"Severe frosts at night, and cold winds by day, so contrary to the expectations of the inhabitants, and so mortifying to us, had now set in; insomuch that such severe weather, even in winter, was never known in the memory of the oldest natives of Trieste. The snow is indeed dissolved, but vegetation continues very languid. Our inclinations lead us to remain sitting at our employment shut up in the warm dining-room, and we were not a little surprised to find the Italians throw open their

doors and windows. Surely this people must have great warmth of constitution.

"It is said that the day before yesterday, in the evening, a man was stabbed and plundered in the street. He had previously been openly counting his money in a public-house. As it is by such conduct a person is sure to attract attention, we thought it right, on the very same day, when, just out of the city, a number of labourers inquired of us what o'clock it was, to reply that we had no watch. Prudence is the parent of security."

"*Hundsberg, April 1.—Qui bien commence a la moitié fait.*" On the 1st day of March we visited Contobello: on the 1st of April we go to Saule. What botanist is not familiar with the name of this place, so rich in plants? Schwægrichen has praised it pre-eminently. We went from our lodging in the direction of Trieste, traversed a great part of the city, and reached the road to Istria, which we kept along for a considerable time. At first the way ascends among hills and stone-quarries, and, in general, passes through a sterile country; where, however, as far as we could judge from the foliage, grew *Artemisiæ*, *Centaureæ*, *Scrophulariæ*, *Verbasca*, &c. At length we saw the sea, and Saule on the right hand, towards which we hastened. The beach is very flat and sandy, affording an excellent opportunity, which has been profited by, for the manufactory of sea-salt;—this is done by dividing the land into compartments by banks, in which the sea-water is admitted, and left to be evaporated by the sun, when the salt is deposited. In such a country it may well be supposed that maritime plants are found abundantly; and it is unfortunate for us that these all have the peculiarity of flowering in the autumn. Here we could distinguish the remains of *Chenopodium*, and *Crithmum maritimum*, *Cakile maritima*, *Statice Limonium*, *Inula crithmifolia*, and *Artemisia crithmifolia*. We gathered some *Confervæ* and *Ceramia*, and found besides a plant that greatly interested us, viz. another undescribed species of dandelion, *Leontodon tenuifolium** *nobis*. It may appear strange to botanists that we should thus daily discover some new plant; yet so it is. We well know, from our own experience,

* Figured also under that name in No. 41. of Sturm's Flora.

that, in new countries, the plants assume a very different appearance. At first, one is dazzled with the novel objects, looking upon them with the eyes of a stranger; but after a while, when we become accustomed to them, we discover their real characters.

"We now wandered along the sea-shore, again came to the road leading to Istria, and by it to a stony hill, where we looked for insects, and found again many of the *Chrysomelæ* which we had observed on the preceding day, lying under the stones, in their hybernacula. Hence we passed over a large stony tract of country, and through many vineyards came again to the beach. In the vineyards an *Euphorbia* was in flower, which had a singular appearance; and on the sea-shore were the remains of maritime plants, similar to that we had seen at Saule. A noble rocky path now passes by the sea to Moja, where we dined. On the old walls of the fortification was flowering *Cheiranthus Cheiri;* but we could not reach specimens, nor determine whether it was the Linnean or Röhling's species. In Moja we were again followed by beggars. One of these thrust himself into the inn with us, and the hostess even permitted him to bring us our wine in an open vessel. Such a thing would never be permitted in our country, and there, probably, would have taken away our inclination for the beverage, but we were now too keen to be very nice.

"The ceiling of the place where we dined (for in the inns here they have no distinct apartment for the guests) was hung entirely with ears of maize. Twenty-five ears made a bunch, and hundreds of such bunches were suspended, which did not look amiss. We returned home late, with our botanizing box well filled."

"*Hundsberg, April 2.*—It is well that we made our collections yesterday, and thereby provided employment for to-day; as the north wind blows dreadfully, and flakes of snow are actually falling. On examining our *Euphorbia*, it proves to be only *E. Helioscopia.* How was it that we did not recognise it yesterday? Because it was procumbent, branched from the base, and flowering in the spring. Who ever saw this to be the case with *E. Helioscopia?*

"Our *Leontodon tenuifolium* has the following characters:

"*Leontodon*, calyce exteriore erecto, squamis ovatis, foliis linearibus vel lineari-lanceolatis integerrimis, scapo glabro unifloro. *Hab.* In pratis et fossis salsis prope Saule, vicinia Tergesti. Floret Aprili.

"The plant bears the same affinity to *L. lividum* (of Waldstein and Kitaibel), that our *L. Taraxacoides* does to *L. Taraxacum*. It is very different from our *lividum*, which grows in wet meadows. Future comparison, and farther investigation, together with the raising of the plant from seed, must determine whether all these individuals now mentioned (to which may be added *L. erectum*, the *Scorzonera Taraxaci* of Roth), can stand as so many species, or whether they must not be rather regarded as so many varieties of the same."

"*Hundsberg, April* 3.

"Diffugêre nives, redeunt jam gramina campis,
Arboresque comæ."

"We sallied out early this morning to explore the hills towards Obschina. With this view we turned to the left on quitting our lodging, and took a northerly course. On the declivities of the hills that are exposed to the south, are numerous vineyards, which frequently check the progress of the botanist. In these, however, as well as on the inside of the walls, are many plants which at present only display their old stalks or young leaves, so that what they are is unknown to us. The uncultivated parts of the hill are covered with oak wood; but, unfortunately, here are no old trees, which afford so excellent harbour for insects, the largest not exceeding a foot in diameter. The underwood is mostly formed of bushes of oak, mixed with juniper and heaths, as well *Erica herbacea* as *Calluna vulgaris*. The soil is clayey, and as there has been no steady rain for these two months, the earth is very dry, and as hard as if it had been rolled. Under these disadvantages, to which are added nightly frosts, continued NE. winds and dry weather, it may be easily supposed that vegetation can make no progress. The boasted flowery spring of Trieste is not, it appears, much to be depended upon; and we are of opinion that in our country, if the snow is not still deep, the Flora is more advanced than here.

Our excursion of to-day was not very extensive; but the ground was so uneven that we descended five or six times into the valleys, and again climbed the hills. We found some common beetles, but no plants. Some *Carices* appeared, for example *C. præcox, collina*, and *humilis*. We had now gone round to the right of Trieste, had the Adriatic Sea in view, and were close upon Contobello, when we saw a little plant in flower on the declivity of a mountain, the sight of which gratified us exceedingly; it was the beautiful *Erythronium Dens-Canis, (Dog's-tooth Violet.)* Most of the specimens, unfortunately, were out of flower; and it was only after a long search, that we found some in a state fit to be gathered for our collections.* It is a plant that merits a place in every garden; its spotted foliage and graceful flowers vieing with those of the *Cyclamen*. The leaves were partly covered with a species of *Æcidium*. We offered money to a boy, to discover some more specimens, and he shortly brought us so many, though chiefly out of flower, as almost to exhaust all our cash. Thus it nearly befel us as it did the conchologist at Copenhagen, to whom a sailor had given a scarce muscle. Wishing to have some of it, he offered a ducat for every one that the sailor should bring him, who soon fetched him as many as would fill a wheelbarrow *."

" *Hundsberg, April* 5.—We employed the whole of yesterday in laying out our plants, and observed that among the specimens of *Erythronium*, were several with white flowers.

To day we made a long excursion to Duino. We did not forget the tree which we had observed on our journey from Gortz hither. The barrenness of the soil, of which we then complained, is not even yet much improved. The whole is

---

* There is scarcely a zealous follower of any department of natural history, who cannot bring forward some anecdote of this kind. We remember, when entomology occupied a greater share of our attention, than it does at present, that, being on the summit of Ingleborough in Yorkshire, a very rare beetle caught our attention, the *Carabus glabratus*, not then known to be a native of Britain. We showed it to the guide, who said it was common, and he could find us plenty. So little did we credit him, that, trusting to his ignorance of insects, we offered him a shilling each, for all that he would bring. Luckily for our pockets, he came to us when he had found half a dozen only, and thus gave us an opportunity of putting an end to this, on our parts, unprofitable bargain, for we had, by that time, discovered for ourselves, as many as we could desire.—Ed.

known by the name of *Karsch*, and except a few rock plants it yields but little. Our tree, which is probaly a *Carpinus*, has its catkins much more expanded, and besides it we have found nothing new. We returned by the high road which leads to Obschina. Some *Papilios* were on the wing, together with *Cetonia hirta*. *Curculio Germanus* was found under stones, and in dung the usual *Sphæridia*, and *Aphodia*. The common *Carices*, and *C. humilis* in particular, are still in flower."

"*Hundsberg*, *April* 6.—With the botanists, Saturday has its peculiar employments, for then we go into the city and purchase various commodities that are necessary to us, and visit the flower, fruit, and fish markets. Though the former contains more of the products of the garden than of the woods, we nevertheless see *Ericæ*, *Pulsatillæ*, and *Violæ*, which constitute the botanical character of a country. In the fish-market are sometimes found the sea-urchin (*Meerigel*), and *Capi Santi* * (*Ostrea Jacobæa*); *Cardium rusticum*, *Venus reticulata*, *castrensis* and *Galena* are very common, as is *Murex cornutus*. The numerous pyramids of sweet oranges, and lemons, give, even at a distance, a peculiar character of splendor to the fruit-market, which is increased, as you approach near, by cocoa-nuts, and *piniolen* †; figs, almonds, raisins, dates, &c. The selling of wine in open pails, which stand exposed to the sun, was not so agreable a spectacle to us as the quantity of roasted chesnuts which are seen in the open streets.

"As the cork which we purchase here is not very good for our insect boxes, we have contrived another plan. We cut large bottle corks into three or four pieces, fasten them to the bottom of the box by means of gum, and secure the whole with a sheet of paper, so that none can get loose and injure the insects."

---

* So called because the Pilgrims who had visited the Holy Land, wore these shells in their hats. Many conchologists have asserted that the scallop shell employed to designate the crusade, was the *Ostræa maxima*, but, in confirmation of our present idea, that the *Capi Santi*, as the *Ostræa Jacobæa* is called at Trieste, is the pilgrim's badge, we have the further authority of the great poet of the north, in these words,

> "He shews St James's cockleshell;
> Of fair Montserrat, too, can tell."—Ed.

† These *Piniolen* are, I believe, the seeds of the *Stone Pine*, (*Pinus Pinea*), which are much eaten in Italy.—Ed.

" *Hundsberg, April* 7.—We had agreed with a countryman of ours, M. Gmeiner, a merchant, to take us on an excursion to Masculi, but the continual rains prevented it.

" Whilst we were absent on our journey to Venice, M. Brandenberg found a plant on the Hindsberg, which from the description, we concluded to be a *Pulsatilla.* As, however, when this gentleman saw our *Dogs-tooth Violet,* he declared it to be that plant, we hastened to look for it, and found it growing rather plentifully on the northern declivity of the hill, scarcely a quarter of an hour's distance from our lodging, under juniper and oak bushes. We also saw here a large specimen of the *Lizard* (*Lacerta Salamandra*), which the warmer sun had invited out The country people wondered how we could take this animal into our hands, and thought that we must possess some peculiar art, which prevented it from biting us; but when we put it close to our faces, they immediately all ran away. Thus many a poor harmless animal, who is happy enough, if permitted to live unmolested by the path side, can alarm *man*, (though gifted with reason, and able to tame lions and tigers), purely from his ignorance of natural history."

" *Hundsberg, April* 8.

" *The wood by Lippiza, two long hours from Trieste, which Scopoli so much extols.*"
SCHWÆGRICHEN in his *Bot. Tasch.*

" To day we have been botanizing in the famous forest of Lippiza, which we saluted, *en passant,* on the 5th and 6th of March. We therefore took the same road which we did then, over the Monte Spicata, nearly to Bassowitza. Not wishing to be detained by an examination at the custom-house, on the boundary, and the wood lying on the left hand, we got over the walls which surround the grassy or rather stony fields, in order to arrive at it the sooner. Before, however we succeeded, we had to walk across a piece of land, a quarter of an hour in length, for which we have no name, and which must, therefore, be described. The whole soil is covered with stones, which lie so thick, as scarcely to leave room for a foot to be placed between them. They are from two to three, and even four feet long, and lie with their sharp edge upwards. The difficulty therefore, of walking over them may easily be supposed. The *Stony Sea* would not be an improper name for this place. After a great

deal of trouble, we at length came to the wood itself, which is encircled by a wall, though it appears to be an hour long, and equally wide.

"On our entrance, we were agreeably surprised by Flora's presenting us with a couple of charming spring plants in blossom, the *Snowdrop* (Galanthus nivalis), and *Green Hellebore* (Helleboris viridis), which had taken possession of the soil by hundreds of specimens. After we had rambled through a considerable part of this, to us new, botanical field, we were enabled to form some judgment of its riches. The wood entirely consists of an *Oak*, which is unknown to us. It is of a middling size, at the most not exceeding 20 feet in height, and about a foot in the diameter of its trunk. This, together with its bark, and the spinous calyx of the fruit, which lay on the ground, proved to us that it was none of the usual species.

The underwood consists principally of *Hazel bushes;* the ground is every where stony and plain, but yet has numerous cauldron-like pits, from 20 to 30 feet in diameter, and covered with bushes. The flat ground produces many plants, the shady pits still more, but at present few of these can be ascertained The *Pæonia officinalis*, which has already put out its leaves, is found in every part of the wood. *Carex humilis, Holcus australis* *, *Globularia vulgaris* and *Thlaspi præcox*, of Wulfen, are in full flower. In the pits, and on their shady sides, flowered *Galanthus nivalis*, *Hepatica nobilis* (Schrank), *Anemone ranunculoides* and *nemorosa*, *Ornithogalum Persoonii*, *Scilla bifolia*, and *Dentaria enneaphylla*. The most interesting plants to us were the *Erythronium Dens Canis*, *Isopyrum thalictroides*, and a *Pulsatilla*. The first individual is a singular variety, with deep red petals, that are rolled back like those of the *Martagon Lily*. After we had dug up a great number of specimens, we gathered flowers to place as a bouquet in our hats. The *Isopyrum* we here saw for the first time in our lives, and it consequently gave us no small pleasure. The *Pulsatilla* we do not know. It seems to be intermediate between *P. vulgaris* and *P. pratensis*, but distinct from both. The differences, however, appear chiefly to consist in the habit of the plant. In comparison with *P. vulgaris*,

* This belongs to the genus *Hierochloe* of Mr Brown; another species of which is the rare *Hierochloe borealis* of Hooker's *Flora Scotica*.

the whole is smaller; it produces always one flower from a root, the colour of which is a dark violet, and which droops but little; in which two particulars it comes nearer to *P. pratensis*, from which again it differs in the flower being larger, and the points of its petals not so much bent back. The leaves are but imperfectly expanded.

We were now perfectly satisfied with the success of the day; but the best part of it was yet to come. We had seen, here and there, on stony spots, a white-flowered crocus, as well as one of a bluish colour, under some bushes near Bassowitza, both of which we took for varieties of Crocus vernus; and thought but little about them at first, as they were much injured by the frost. But, at the moment that we were coming out of the forest into the road, we saw a pit which was completely covered, as with a table-cloth, by the white-flowered crocus. It was in full blossom, and offered to us beautiful specimens. The frost had not gained admittance here, and decayed leaves had afforded them excellent manure. On digging up our plants, we soon observed the other kind, which we took up also. But what a discovery was this! It required but a casual glance to satisfy us, that our two *Crocusses* are essentially different. We must now call upon all the botanists who have hitherto admired our zeal and enthusiasm, to take part with us in the pleasure which this occurrence afforded us. We felt all the sensations that M. Mayer had expressed in a letter to us, when he first found, on the Kahlenberg, near Vienna, the *Ophrys arachnites* and *myodes*, and the *Cypripedium Calceolus*. "On such occasions," he says, "I cannot refrain from making the most ridiculous antics. I throw up my hat, and bow low before the stranger; but my respect for him speedily vanishing, the poor plant is unceremoniously and unmercifully cut up from its native spot." To return, however, to our new *Crocus*. We remembered, tolerably correctly, the species hitherto defined of that genus; for example, *C. neapolitanus*, (Tenare), *viridiflorus* (Smith), or *multifidus* of Ramond; *Masiacus* (Willdenow), and *biflorus* (Smith); from all which, as also *C. autumnalis*, our plant differs essentially. We shall, on farther examination, give its characters.

After we had cooled and refreshed our box of plants, in some snow which we found outside the wall of the wood, we returned home in the evening, well satisfied with the produce of the day."

Our travellers then drew up the following character of their new *Crocus variegatus*, as contrasted with that of *Crocus albiflorus*.

Crocus albiflorus, Kitaibel.	*Crocus variegatus*, Hoppe & Hornschuch.
Bulb round, one placed above the other, the uppermost one the smallest; its coat brownish, composed of a single net-work of fibres, permitting the root to be seen through it; *Leaves* two, rather broad; *Flower* of six segments, the divisions somewhat long, elliptical, blunt; the three outer ones larger than the inner, all white; the *Stigma* wedge-shaped, slightly 3-cleft, the divisions dentate.	*Bulb* between ovate and round, one placed above the other, the upper one the largest; its outer coat yellowish, composed of many layers of fibres, concealing the root; *Leaves* 4, very narrow; *Flower* of 6 segments, the divisions lanceolate, acute, all of the same size, pale blue, the back of the three outer *petals*, with dark stripes; spreading out like rays; *Stigma* linear, deeply 3-cleft, the divisions bi or trifid.

ART. X.—*On the Existence of Two New Fluids in the Cavities of Minerals, which are immiscible, and possess remarkable Physical Properties.* By DAVID BREWSTER, LL. D F. R. S. Lond. & Sec. R. S. Edin. *.

THE unpublished memoir, of which we now propose to give an abstract, is divided into eight sections, namely,

SECT. I.—On the existence of a New Fluid in the Cavities of Minerals.

II.—On the coexistence of two Immiscible Fluids, of different Physical Properties, in the Cavities of Minerals, and accompanied with a Vacuity.

III.—On the Phenomena of Two Immiscible Fluids without a Vacuity in the Cavities of Minerals.

IV.—On the Changes which these Fluids have undergone in particular Crystals.

V.—On the Vaporisation and Decomposition of the New Fluid at low Temperatures, when enclosed in the Cavities of Minerals.

---

* The following article is a brief abstract of the larger Memoir, read at the Royal Society of Edinburgh, on the 3d and 17th March 1823, and which will appear in the 10th volume of the Society's Transactions, now in the press.

PLATE II.

Fig. 5.

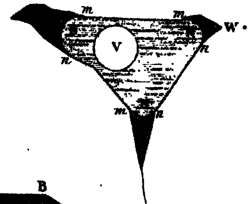


Fig. 2

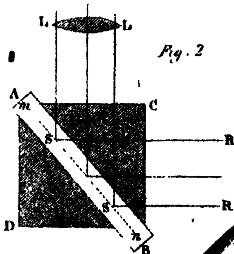


Fig. 1.

Fig. 3

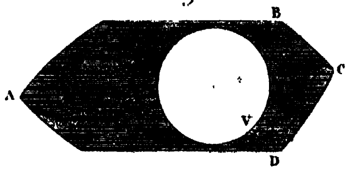


Fig. 4

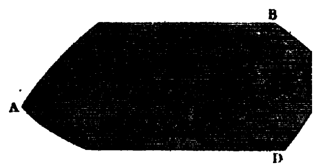


Fig. 6.

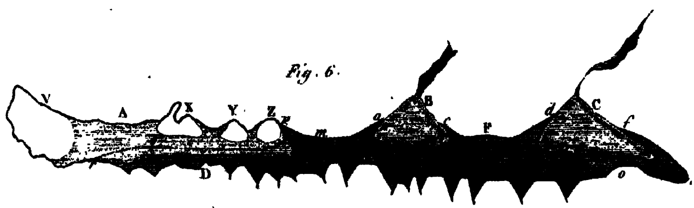


Fig. 7.

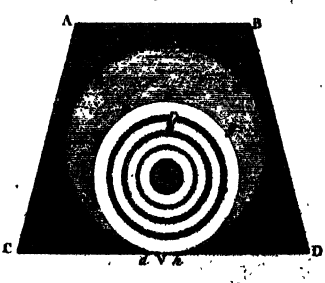


Fig. 8

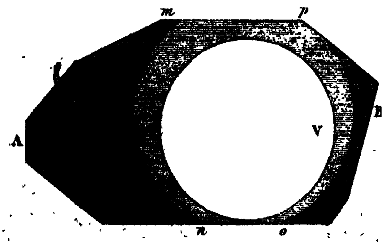


Fig. 9.

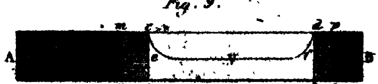
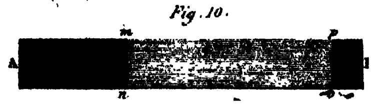


Fig. 10.



Published by A. Constable & C^o Edin^r 1823

W.H. Lizars sc

Sect. I. *On the Existence of a New Fluid in the Cavities of Minerals.*

While examining the cavities of crystallised bodies, our author observed such remarkable differences in the phenomena of the fluids which they enclosed, that he found it impossible to explain them upon the supposition of their being fluids possessing the ordinary properties of that class of bodies. Hence he was led, by the following train of reasoning, to ascribe these phenomena to new fluids, possessing new physical properties.

In examining the Topazes from New Holland, Scotland and Brazil, he observed the cavities arranged in strata. These cavities are sometimes beautifully crystallised, and sometimes amorphous, sometimes extremely shallow, and at other times deep.

They are filled with a colourless and transparent fluid, as shewn at ABCD, Fig. 1. Plate II.,* and have almost always a vacuity V, of a circular form, which moves by an inclination of the plate to different parts of the cavity. The depth of the cavity may be easily estimated, by the breadth of its bounding line ABCD, which, in the flat cavities, is generally the same as that of the circle V. In very shallow cavities, this boundary is a narrow line, scarcely visible, and in deep ones it is broad, with a penumbral termination inwards, arising from the deviation of the light at the separating surfaces of the fluid, and the topaz, and at that of the fluid and the vacuity.

When the hand is applied to the crystal, the heat of it gradually expands the fluid. The vacuity V consequently diminishes, and being in a short time reduced to a physical point, it entirely disappears. When the fluid again cools, by withdrawing the hand, it of course contracts, and quits the sides of the cavity. The vacuity V reappears, increasing till it resumes its former

magnitude; and it deserves particular notice, that the evanescence and reappearance of the vacuity takes place simultaneously in many hundred cavities, of the same general form, which may be seen in the field of view.

In order to obtain an accurate measure of the temperature at which the vacuity reappears, which is almost the same as that at which it vanishes, our author plunged the topaz in heated water, and, by means of an accurate thermometer, obtained the following results:

Nature of the Cavities.	*Temperature at which the Vacuity reappeared.*
1. Topaz from New Holland, with shallow cavities, -	74½°
2. Blue Topaz from Aberdeenshire, with cavities of different forms,	74°—82°
3. Colourless Topaz from Brazil, -	79½°
4. Topaz from New Holland, with large and rugged cavities,	79¾°
5. Topaz from New Holland, with a very flat cavity, -	81¼°
6. Another colourless Topaz from Brazil, with a deep cavity,	83°¾

When the cavities are very small and narrow, only one vacuity reappears; but when they are large, several small circular vacuities make their appearance, and gradually unite into one, though sometimes they remain permanently separate. When the cavities are deep, a very remarkable phenomenon accompanies the reappearance of the vacuity. At the instant that the fluid has acquired the temperature at which it quits the sides of the cavity, a rapid ebullition takes place, and the transparent cavity is for a moment opaque, with an infinite number of minute vacuities, which instantly unite into one vacuity, that gradually enlarges as the temperature diminishes.

In order to determine the expansion which takes place by a given increment of temperature, our author measured the relative size of the vacuity, and the cavity at the temperatures of 50° and 80°, the temperature at which the fluid had expanded so as wholly to fill the cavity. In many cases this could be estimated with tolerable accuracy, and it may be stated in general, from the estimates and measures taken by different persons, to whom the cavities were shewn, that the fluid expands fully *one-fourth* of its size, by an increment of 30° of heat; and that it *is nearly 32 times more expansible than water, by an increment of 30° of heat at the temperature of 50°.*

This extraordinary result proved beyond a doubt, that the substance contained in the cavity was a new fluid, differing from all known fluids in its high expansibility, and resembling in this respect a gaseous more than a fluid body.

In order to confirm this result, our author was desirous of examining the other physical properties of this remarkable substance. He noticed, in the deep cavities especially, the singular volubility of the fluid, and its slight adherence to the sides of the cavity, as indicated by the motion of the vacuity V. In small cavities containing water, the adhesion of the fluid to the stone is so strong, that the air-bubble moves with extreme difficulty, and even when very large, it often changes its place by starts, and remains stationary at the bottom, or in the middle of the cavity. In the present case, however, the vacuity moved about with great facility, and in the cavity, $\frac{1}{25}$th of an inch long, by $\frac{1}{38}$th and $\frac{1}{62}$d of an inch wide and deep, the slightest tap of the finger on the microscope caused the air-bubble to tremble and oscillate in this microscopic level. Hence the new fluid is distinguished by a second physical property, no less remarkable than the first.

Although no doubt was now entertained of the accuracy of the conclusion, that the fluid was a new one, yet it was conceived possible to obtain an approximate measure of its refractive power, and thus to put its novelty beyond the reach of a doubt. In order to do this, it became necessary to observe the manner in which the total reflexion of the upper surface of the cavity was modified by the contact of the fluid, and to measure the angle at which total reflexion was effected, by the separating surface of the fluid and the solid. For this purpose our author took a plate of topaz AB, Fig. 2., with a stratum of cavities *m n*, perfectly parallel to the natural surface of the plate. He then placed upon each surface the rectangular prisms ABC, ABD, and introduced between them a thin film of oil of cassia. Rays of light RS, RS were then allowed to fall upon the stratum of the cavities *m n*, so that the rays reflected from the upper surface of the cavity could be examined by a microscope, whose object lens is LL. Upon making this arrangement, the stratum of cavities was seen in the most beautiful manner. The vacuity V, Fig. 3, of a cavity seen in this way, shone with all

the brilliancy of total reflexion, the separating surface of the new fluid ABCD, and the cavity, exhibited a faint grey tint, while the surrounding portions of the solid topaz were comparatively black. The variations which the vacuity V undergoes by heat are now finely seen, and, at a temperature of 80°, it vanishes in a brilliant speck, leaving the whole of the cavity ABCD of the same uniform tint as in Fig. 4.

The phenomena now described are not so distinctly seen when the stratum *m n* is deeply seated beneath the surface of the topaz, in consequence of the duplication and overlapping of the images formed by double refraction.

This inconvenience, however, may be nearly removed by making the plate of topaz very thin; or it may be entirely remedied, in plates of any size, by making the incident rays RS pass along one of the resultant axes of the topaz, while the reflected rays SL pass along the other resultant axis.

In order to compare the angle at which total reflexion took place at the upper surfaces of the fluid and cavity, with that which would have taken place had the fluid been water, a drop of water was placed on part of the lower surface of the plate AB, Fig. 2., and it was found that the light reflected at the same angle of incidence, was much more brilliant from the separating surface of the new fluid and the cavity, than from the separating surface of the topaz and the water, a result which indicated, in the most unequivocal manner, that *the new fluid had a refractive power inferior to water, and that it differed in this respect from every other known fluid.*

With a specimen of *Amethyst*, our author was enabled to determine, that the refractive power of the expansible fluid was about 1.211.

In the remainder of this section, the author describes analogous phenomena in *Cymophane*, *Quartz*-Crystals from Quebec, and *Amethyst* from Siberia, the last of which is a specimen of very great interest from the cabinet of Mr Allan. In these crystals the vacuities reappear as follows:

Cymophane, - - - -	83°½ Fahrenheit.
Quartz from Quebec, different cavities in the same specimen, - - -	76° 80° 125°
Amethyst from Siberia, - - -	83°½

Sect. II.—*On the coexistence of two Immiscible Fluids, of different Physical Properties, in the Cavities of Minerals, and accompanied with a Vacuity.*

The phenomenon of two immiscible fluids, as exhibited in Topaz, is represented in Fig. 5. where V is the vacuity, NNN the new fluid, and WWW another fluid, which we shall distinguish by the name of the *Second Fluid.* This second fluid WW commonly occupies the angles of triangular cavities, as in Fig. 5, or the terminations of longitudinal ones. It is always separated from the new fluid by a curved surface *m n*, *m n*, &c. It never expands perceptibly with heat, and never mixes with the new fluid NN. By a little management, the vacuity V may be made to come in contact with the bounding lines *m n*, *m n*, &c.; but it never affects its curvature, and seldom enters the fluid W. When the vacuity V has been made to vanish by heat, these bounding lines remain exactly the same.

Having at first observed this second fluid only in the angles of cavities, as in Fig. 5., considerable difficulty was experienced in proving that it was a fluid. The difficulty of conceiving two fluids existing in a transparent state, in absolute contact, without mixing in the slightest degree, induced several persons to refer it to an optical illusion, and to consider the line which separated it from the new fluid as a septum or partition in the cavity. The beautiful curvature of the bounding line, however, and its perfect similarity to that of two contiguous fluids, rendered this supposition untenable.

Having found specimens in which the second fluid occupied a large part of the cavity, most of the difficulties which had formerly presented themselves were removed; but something was still wanting to prove its fluidity. This desideratum was fortunately obtained in a specimen of topaz belonging to Mr Sivright. In examining this specimen, I observed a very remarkable cavity, of the form shewn in Fig. 6., where A, B and C are three separate portions of the new fluid (shaded lightly), insulated by the interposition of the second fluid DEF (shaded darkly). The first portion A of the new fluid had four vacuities V, X, Y, Z, while the other two portions B, C, had no vacuity. Having often succeeded in making the vacuities

pass from one branch of a cavity to another branch, our author did not doubt that the vacuities of the portions B and C had passed over the second fluid into the portion A. In order to determine this, an accurate drawing of all the phenomena was taken at a temperature of 50°, as represented in Fig. 6., and the changes carefully watched which took place by raising the temperature to 83°. The new fluid at A gradually expanded itself, till it filled all the four cavities W, X, Y, Z; but as the portions B, C, had no cavities for this purpose, they could only expand themselves, by pushing back the supposed second fluid DEF. This actually happened. The second fluid quitted entirely the edge of the cavity at F. The two portions of new fluid B, C, were immediately united into one; and the second fluid having retreated to its new limit *m n n′ o*, and being itself but slightly expansible, like common fluids, its other limit necessarily advanced to *p q r*. This experiment, which has often been repeated, and shewn to others, involves one of those rare combinations of circumstances, which Nature sometimes presents to us, in order to lay open some of the most mysterious of her operations. Had the portions B, C, of the *new fluid* been accompained, as is usual, with their vacuities, the interposed *second fluid* would have remained immoveable between the two equal and opposite expansions: but, from the accidental circumstance of these vacuities having passed over into the other branch A of the cavity, the *second fluid* is placed in a sort of unstable equilibrium, and, like the arms of a lever, it yields to every variation of the power and of the resistance.

If any additional evidence were wanted on this subject, we have only to examine the mode in which the two portions of the new fluid B, C, are united into one, by a disunion of the second fluid at *g h*, and again separated by its reunion. Upon the application of heat, the summits *g h* become more acute, and gradually approach to each other, till they suddenly unite, and force back the surface of the second fluid into the line *m n n′ o*. A portion of the second fluid, however, is retained by capillary attraction, in the angular meeting of the planes, between *c* and F, and between *d* and F, and also a small portion at *f*, a phenomenon which affords an ocular explanation of the immobility of the

second fluid in the terminations and angles of cavities. When the fluids again cool, the surface *n n'* approaches to *c d*, and when *n* is near *c*, the two surfaces *n n'*, and those of the same fluid in *c* F and *d* F, suddenly start into union, in virtue of their mutual attraction, and the portions B and C are again separated.

In order to examine the refractive power of the second fluid, our author made the arrangement represented in Fig. 2., and found that the second fluid W always reflected less light than the new fluid, and consequently that its refractive power approached nearer to topaz than the new fluid. By the same means, he determined, that the angle at which total reflexion took place at the separating surface from the topaz, was very nearly the same as if it were water.

Two immiscible fluids, possessing the properties now described, exist also in *Quartz*, *Amethyst*, and *Cymophane*, and there is reason to conclude that the one never occurs without the other, as the second fluid has, in almost every case, been discovered in cavities where the difficulties of observation had at first prevented it from being detected.

Passing over the *third* section, in which our author explains the phenomena of two immiscible fluids coexisting without a vacuity; and also the *fourth* section, in which he shews that the fluids are sometimes indurated like a resinous substance within the cavities, we come to

Sect. V.—*On the Vaporisation and Decomposition of the New Fluid at low Temperatures, when enclosed in the Cavities of Minerals.*

Let ABCD, Fig. 7., be the summit of a crystallised cavity in Topaz, and let the length of the cavity be in a vertical direction, so that SS is the second fluid, NN the expansible fluid, bounded by a circular line *a b c d*, and V the vacuity in the new fluid, bounded by the circle *e f g h*. Let the face ABCD be placed under a compound microscope, so that the rays of a luminous body incident upon it, may be reflected at an angle less than that of total reflexion. When the observer now looks through the microscope, the temperature of the room being 50°, he will see the second fluid SS shining with a very feeble reflected light, the new fluid NN with a light perceptibly brighter, and the vacuity VV with

a considerable brilliancy. The boundaries *a b c d*, *e f g h*, are marked by a well-defined outline, and also by concentric coloured rings of thin plates, produced by the extreme thinness of each of the fluids at the edges.

If we now raise the temperature of the room gradually to 56°, we shall observe a brown spot appear in the centre of the vacuity V *e f g h*. This spot marks the visible commencement of evaporation from the new fluid below, and arises from the attenuated vapour which attaches itself to the roof of the cavity. As the heat increases, the brown spot enlarges, and becomes very dark. It is then succeeded by white, and one or more rings rise in the centre of the vacuity. The vapour then seems to form a drop, and all the rings disappear, by retiring to the centre, but only to reappear with new lustre. During the application of heat, the circle *e f g h* is in a state of constant contraction and dilatation, like the pupil of the eye when exposed to light, being always greatest when the rings disappear, and contracting its dimensions when they are again formed.

When the vaporisation is so feeble as to shew itself only by a single ring of one or two tints of the second order, these tints may be made to disappear instantly by the slight degree of heat arising from a single breath upon the crystal; and the same effect is produced by the approximation of a heated body. When the heat reaches the fluid, however, it makes it throw off fresh vapour, and the rings again appear.

If we put a drop of Ether upon the crystal when the rings are in a state of rapid play, the cold occasioned by its evaporation immediately causes them to disappear, till the temperature again rises.

When the temperature is perfectly uniform, the rings remain stationary, and it is interesting to observe the first ring produced by the vapour swelling out to meet the first ring at the margin of the fluid, and sometimes coming so near it, that the darkest parts of both form a broad black band.

As the heat increases, the vacuity V advances to the summit AB, and disappears at 79½°, exhibiting several curious phenomena which we have not room to describe. One of these, however, is so singular that it deserves to be particularly noticed. After the vacuity V *e f g h* has disappeared entirely, a brown

spot comes from the summit AB, and takes its station in the centre of the ring of new fluid *a b c d*. This brown tint sometimes rises to higher orders of colours; but disappears by the application of heat. That the coloured rings formed within VV are vapour, and not a film of the fluid itself, may be inferred from its never mixing with the fluid with which it is in immediate contact. It might, however, be a fluid substance, arising either from the decomposition of the fluid itself, or from the condensation of gaseous matter within the vacuity; though this is not very probable, from its constant disappearance when it has accumulated to a certain degree, and its constant reproduction while the temperature remains the same.

These views respecting the vaporisation of the expansible fluid, have been fully confirmed by the discovery of cavities, in which the expansible fluid occupies only *one-third* or *one-fourth* of the cavity. These cavities are represented in Fig. 8., where AB is the cavity, V the vacuity in the expansible fluid *m n o p*, and A *m n*, B *p o* the second fluid. When heat is applied to this cavity, the vacuity V does not contract, as in ordinary cases, but *expands*, till its circumference coincides with the boundary *m n op*. This unexpected effect might have arisen from the expansible fluid occupying the lower part of the cavity below V, as in the section, Fig. 9. In this case *c e f d* might have been the vacuity, and the surface of the fluid *e f* might have risen by heat, and gradually filled the vacuity V, while its boundary at *c* and *d* retired to *m* and *n* as *e f* ascended. In order to determine if this supposition was true, I placed AB vertically between two rectangular prisms of glass; and having examined in succession the light reflected from the surfaces *m p* and *n o*, I found that it had suffered total reflexion, both from the side *c*,*d* and the side *g h* of the vacuity, and consequently that the vacuity occupied the whole thicknesss of the cavity. After the heat was applied, the sides *c d* and *g h* continued equally luminous, and when *c g* and *d h* had retreated to *m n* and *p o*, as shewn in Fig. 10., it became quite manifest that the space *m n o p* was not filled with the *expanded fluid*, but with the fluid *in the state of vapour*. The coloured rings at first appeared both on the faces *c d* and *g h*, and when the whole was converted into vapour they disappeared, and the light reflected from both the surfaces *m p*,

n o, which was now uniform, was not that of total reflexion, nor yet that of the expanded fluid, but of an intermediate intensity, corresponding to that of a dense vapour, with a refractive power much lower than 1.211.

There is another set of phenomena of exquisite beauty to an optical observer, which seem to arise either from the decomposition of the fluid, or the condensation of gaseous matter in the vacuity.

When heat is applied to the cavity, the new fluid has its surface in a state of constant agitation, resembling, in the closest manner, a surface into which a fluid is discharging itself by drops. When the vacuity is just filled up, one or more drops quit the point where the vacuity disappeared, and pass along the surface of the cavity, like a drop of oil adhering to it in close contact, and never mixing with the fluid. Each of these drops begins in a short time to spread circularly, and to exhibit within its disc an immense number of close coloured rings. By slow cooling the drops become thinner, and the rings less numerous, and more completely displayed, till they entirely disappear at a particular temperature. When the cooling is effected quickly, the matter which composes the thin plate that exhibits the rings, discharges itself rapidly in gaseous bubbles.

SECT. VI.—*On the Phenomena of the two New Fluids when taken out of the Cavities.*

From the extreme minuteness of the cavities in topaz, our author's first attempts to extract the fluid were not attended with much success; but he at last fell upon a method by which he has opened more than a hundred cavities.

When the most expansible of the new fluids first runs from the cavity upon the surface of the topaz, it neither remains still, like the fixed oils, nor disappears, like evaporable fluids. Under the influence, no doubt, of heat and moisture, it is in a state of constant motion, now spreading itself in a thin plate over a large surface, and now contracting itself into a deeper and much less extended drop *. These contractions and ex-

* A round hemispherical drop often stretches itself into a plane of more than twelve times its original area.

tensions are marked by a very beautiful optical phenomenon. When the fluid has extended itself into a thin plate, it ceases to reflect light, like the most attenuated part of the soap-bubble, and when it is again accumulated into a thicker drop, it is covered with all the coloured rings of thin plates. When one of the drops of fluid is very minute and perfectly circular, it resembles, in the most accurate manner, the small drops which pass from the vacuity, and which have been described in the preceding section.

After performing these motions, which sometimes last for ten or twelve minutes, the fluid suddenly disappears, and leaves behind it a residue of minute and separate particles, which are opaque by reflected, but transparent by transmitted light. Upon examining this residue with a single microscope held in the hand, it again started into a fluid state, and extended and contracted itself as before. This was owing to the moisture of the hand; and our author could at any time revive the indurated substance, by the approach of a moist body. A portion of the fluid, which was taken out of a cavity twenty days ago, is still capable of being restored to a fluid state by moisture. This portion was shewn to an eminent naturalist, the Reverend Dr Fleming of Flisk, who remarked, that, had he observed it accidentally, he would have ascribed its apparent vitality to the movements of some of the animals of the genus Planaria.

After the cavity has remained open for one or two days, the second fluid comes out of it, and hardens very speedily into a yellowish resinous-looking substance, which is perfectly transparent. This substance absorbs moisture, but with less avidity than the other. It is not volatilized by heat. It is not soluble in water or alcohol; but it is rapidly dissolved with effervescence by the sulphuric acid. The nitric and muriatic acids also dissolve it.

The residue of the first fluid is volatilized by heat; and it is also dissolved, but without effervescence, by the sulphuric, the nitric, and the muriatic acids. After standing some time, both these substances acquire a brilliant lustre, as if some metallic body entered into their composition.

It would be improper to conclude this paper, says our author, without noticing the relations which are supposed to subsist be-

tween this class of phenomena and the two contending Geological Theories. The existence of highly rarified gas in the cavities of crystals, has been regarded by the distinguished President of the Royal Society of London, as "seeming to afford a decisive argument in favour of the igneous origin of crystalline rocks;" and the "fact of almost a perfect vacuum existing in a cavity containing an expansible but difficultly volatile substance," (as naphtha), he likewise considers as highly favourable to the same theory. The discovery of compressed gas in similar cavities might have been regarded as neutralising in some degree the first of these arguments: but Sir Humphry Davy remarks, that it may be explained, by supposing the crystal to have been formed under a compression much more than adequate to compensate for the expansive effects of heat.

Without presuming to combat these deductions, or to suggest any of the numerous explanations by which the Neptunist might reconcile with his own system the compressed and dilated condition of the included air, I shall content myself with stating, that the facts described in the preceding paper appear to me decidedly hostile to the igneous origin of crystals, and, in some points of view, favourable to their aqueous formation. The existence of a fluid which entirely fills the cavities of crystals, at a temperature varying from 74° to 84°, may, upon the principles assumed in the opposite argument, be held as a proof that these crystals were formed at the ordinary temperature of the atmosphere, while the fact of a perfect vacuity existing in *sulphate of barytes*, and capable of being filled up by the expansion of the aqueous fluid, at a temperature not exceeding 150°, authorises the analogous conclusion, that the crystal could not have been formed at a higher temperature. On the other hand, the filling up of the vacuities in *sulphate of iron*, and *sulphate of nickel*, at a temperature much above that at which they were formed *, may lead geologists to renounce a species of argument which appeals only to our ignorance, and to withdraw from the defence, even of their outworks, those faithless auxiliaries which are so ready to enlist themselves in the service of either power.

---

* The phenomena here alluded to will be described in a subsequent number. They are fully explained in the original memoir.

There is one geological relation, however, of the preceding facts, which may deserve some attention. Hitherto the contending theorists have limited their idolatry to two of the elements; but the existence of two new substances in minerals, one of which combines a great degree of fluidity with the high expansive power of the gases, renders it probable, either that these substance existed at the formation of the globe, or that they are the result of laws of crystallographic combination which have escaped the notice of the philosophical geologist. Were such fluids the product of the ordinary processes of crystallization, they would occur in artificial as well as in natural crystals: and, consequently, while they remain undiscovered in the cavities of the first of these classes of bodies, we are entitled to attach a new difficulty to the aqueous hypothesis.

Had the two new fluids occurred only in one mineral, or in minerals of a particular composition, they might have been supposed to have some relation to the elementary principles of the body, and to have arisen either from some accidental irregularity, which prevented them from crystallizing, or from the decomposition of the matter subsequently to its crystallization. The perfect identity, however, of the two fluids, as found in pure Quartz, in Amethyst, in Topaz, and in Cymophane,—minerals brought from the most opposite parts of the globe,—from Scotland, Siberia, New Holland, Canada and Brasil,—establishes the universality of their existence, and adds to the probability of the supposition that they have performed some important function in the organization of the mineral world.

Art. XI.—*Observations on the Natural History and Structure of the Aquatic Salamander, and on the Development of the Larva of these Animals from the Egg, up to the perfect Animal, by* Maurò Rusconi, M. D. *Member of various Societies, and lately Lecturer on Physiology in Pavia* *.

In two former papers †, I communicated the substance of a memoir on the Proteus Anguinus, by Professor Configliachi and Dr

* Read before the Wernerian Natural History Society, April 4. 1823.

† Edin. Phil. Journ. vol. iv. p. 398,—and vol. v. p. 84.

Rusconi of Pavia. While employed on the Proteus, Dr Rusconi directed his attention to the larva of the Aquatic Salamander, which, in many points of structure, bears a near resemblance to the proteus. He then also described, shortly, the amours of the salamander, and the mode in which the egg is deposited by the female *; and, farther, announced his intention of speedily publishing a more detailed account. This intention he postponed for some time, from a desire of accompanying his work with comparative sketches of the structure of the Sirena lacertina; but having, for the present, been disappointed in his efforts, both in Europe and America, to procure that animal, he resolved to delay no longer the publication of his researches relating to the salamander. Accordingly, in the year 1821, he printed at Milan, a work entitled "Amours des Salamandres Aquatiques, et Developement du Tetard de ces Salamandres, depuis l'œuf jusqu' à l'animal parfait." Of this work I propose now to give the substance, together with such of the designs as may be necessary to illustrate and verify the anatomical descriptions. In its present state, the inquiry may be deemed to possess a new interest, from the circumstance of the same subject having, so lately as the years 1821 and 1822, been proposed, in the following form, as a prize essay by the Royal Institute of France.—"To trace the gradual developement of the aquatic Triton or Salamander, through its different stages, from the egg to the perfect animal; and to describe the internal changes which it experiences, but principally in regard to osteogony, and the distribution of the vessels †."

Dr Rusconi commences his memoir by expressing surprise that the natural history of the aquatic salamanders, which are so common in the marshes of Italy, should be so imperfectly known. Hitherto, the observations made upon them have been more particularly confined to their astonishing powers of *reproduction*; while other properties, at least as curious, and still more important, have been almost wholly neglected. In truth, the changes which these animals exhibit, according to age, sex, and season, have not been observed with all the attention they deserve; and it is to this want of attention that we must attri-

* *Del Proteo Anguino Monografia*, p, 35–6–7. Pavia, 1819.

† *Philosophical Magazine*, April 1821, p. 306.

bute the confusion in which this *genus* of vertebral oviparous animals is found in our zoological systems, even those the most recent. Their structure has not yet been sufficiently studied; the mode in which their eggs are laid and fecundated has been only imperfectly observed; the development of the young animal has not been followed with accuracy, nor through all its stages; and, lastly, their *species* has not hitherto been determined with precision. The object of the author in this publication, is to fill up some of these gaps, which, but for the reason above stated, would have been sooner accomplished; for all the designs given in this work were made, and the notes on the natural history of the animal written, before the publication of his work on the proteus in 1819.

Having thus made known the reason of the delay, the author proceeds now to inform the reader of the circumstances which determined him to undertake this branch of the inquiry. Whilst he was occupied in studying the organization of the salamander, and comparing it with that of the proteus, the idea came into his mind of following the development of the salamander from the egg up to the perfect animal. He had learned from the inquiries of Spallanzani, that, in these animals, fecundation was effected exterior to the body of the female; and that, nevertheless, the action of the prolific fluid was propagated within her; and Blumenbach had instructed him, that some salamanders, which were kept in a vessel filled with water, had laid eggs, which were there hatched, and afforded him an opportunity of seeing and examining the gills of the young animal. To satisfy his curiosity on these points, the author believed that nothing more was necessary than to procure females at the time of laying. In the month of May, therefore, he procured several of these reptiles, which he put into a large tub, and three days afterwards he found, at the bottom of the tub, about 30 eggs glued together endwise, three to three, and four to four, so as to resemble portions of a string of beads. These eggs he gathered up with the necessary care and precaution, and placed them in a vessel filled with a portion of the water from the tub. Observing them for two days, he saw them enlarge and become irregular on the surface, which he regarded as a prelude to the evolution of the germ. These appearances increased to the fifth

and sixth days, when, instead of the young animals which he expected to come forth, the eggs had lost their transparency, had become covered with mould, and their faculty of evolution was destroyed.

During this time, the salamanders, which were left in the tub, had deposited other eggs, which he collected as before; and, suspecting that the water he had used might have been improper for the purpose, he now employed that taken from the ditches in which the animals had lived; but with no better success. He next had recourse to methods of *artificial* impregnation, previously executed with success by Spallanzani; but failed in these also. While engaged, however, in these experiments, he observed that the salamanders, which had been left in the tub, pressed back, from time to time, their hind-limbs beneath the belly, and that, in a few moments afterwards, they laid one or two eggs; these eggs did not fall always to the bottom of the water, but sometimes remained attached, for a moment, to the anus itself, in such a way that some of the salamanders might be seen, running here and there in the tub, with two or three eggs thus attached. It was not easy to form plausible conjectures upon this habit of pressing back the legs under the belly, when the eggs were laid. The mode even of their escape from the animal surprised the author, because, trusting to what M. Cuvier had written, he thought that these animals produced many eggs at once, which escaped in succession, and were attached to one another in the form of a necklace. Proposing, therefore, to investigate this point more minutely at another time, but occupied, at present, with the desire only of procuring for his salamanders a suitable habitation, he wished to make such arrangements as should enable the animals, during the night, to support themselves at the surface of the water, in order to respire with greater facility. At this time, a fresh parcel of these animals happened to be brought to him in a pail, in which many of the plants called *Polygonum Persicaria* were placed, with the view of preventing the water from escaping out of the pail. Of some of these plants he made a packet, and placed them in his tub, under a large stone to confine them to the bottom. Towards evening, he visited the tub, and found all his salamanders so commodiously situate, by the aid of the plants, that, by keeping

the head a little elevated, their nostrils were above the surface of the water, so that they could respire with ease. A few days after this, while seeking with his eye for a male and female the most suitable for repeating the experiment of *artificial* impregnation, he remarked, almost without wishing it, that there was not a single egg at the bottom of the vessel. While indulging his surprise at this fact, his attention was recalled by observing one of his salamanders approach towards a leaf of the plant, and direct its snout to it, as if wishing to smell it. He then saw the animal move gently on the leaf, in the direction of its breadth, and, resting upon it, push back the hind-limbs, so as to fold backward and inclose between its feet the leaf on which it rested. It remained about a minute in this position, and then withdrew, leaving the leaf doubled in such a way that its apex was turned back on the petiole. "At the sight of this new fact," says the author, "I forgot entirely the artificial impregnation, and prepared myself to observe, most attentively, what my salamander was to do. Scarcely had three minutes elapsed, when I saw it approach towards another leaf, and apparently disposed to place itself upon it. At this period, casting my eyes accidentally on the branches of *persicaria*, I discovered many other leaves doubled back, like that which I had just seen so disposed by the salamander. I withdrew immediately the packet of plants from the tub, and, examining the leaves, I found that each of them inclosed an egg. I remarked also, that these leaves were unable to redress themselves, because their two surfaces were held together by a kind of glue, with which the envelope of each egg is covered; so that, to open a leaf, I was obliged to overcome the resistance which this glue presented.

"Satisfied so far with this discovery, I set out immediately for the ditches from which the salamanders had been taken, and gathering many branches of *persicaria*, which were in the water, and the leaves of which were similarly folded, I convinced myself, by observing them with care, that the eggs of salamanders do not escape from the animal, like strings of beads, as some naturalists have lately asserted; nor do they fall to the bottom of the water, as Spallanzani, with so much confidence, maintained. I satisfied myself of this truth, by opening all the leaves which I had drawn from the water, and finding in each, as in

those of my tub, an egg concealed. Nay more, I found in one leaf a young salamander already evolved, and which exhibited signs of life by moving and changing its position." The author dwells with great satisfaction on this discovery, which enabled him at once to pursue the object he contemplated, without having recourse to artificial processes.

"My joy," he continues, "was so great, that, having chosen about twenty leaves, each of which contained an egg not yet evolved, I put them into a bucket filled with the water of the ditch, and at once proceeded to my lodging. Arrived there, I poured the water of my bucket, together with the leaves of *persicaria*, into a bason; and having chosen an egg for the subject of my observations, I began my experiment. I shall defer particular details until I come to an explanation of the figures; and, for the present, shall only observe, that there is not, in my opinion, a more agreeable or more curious spectacle than that which the embryo of the salamander offers to the philosophic naturalist, in the portion of time while he is yet in the egg, and for a few days after his escape from it. All that in other animals, passes in the midst of the thickest darkness, is here carried on under the eyes of the observer, who is able to contemplate, quite at his ease, the progressive development of the different parts of the animal; and, by the order which nature observes in this development, is able to conjecture what are the organs the most important and most necessary to the life of the individual. In fact, when we consider the different phases through which the little salamander passes, we might say that Nature, for once, far from shewing herself jealous of her operations, is here pleased to disclose them to our view; for, scarcely has the little animal escaped from its envelopes, than she prepares for the observer a new picture, not less pleasing than the former."

The little animal, which is opaque, and formed apparently of a soft and homogeneous substance, while yet retained in its envelope, becomes gradually transparent, almost as soon as he has escaped from it; so that, if the naturalist has been able to see, through the transparent walls of the envelope, the development of the exterior parts only, he now sees the formation, both of the external and internal parts together. He discovers the heart of the animal, and follows its contractions and dilatations: he

perceives the stomach, and recognises its form and position: his eye is able to distinguish the intestinal canal, which at first extends in a straight line from one extremity of the abdomen to the other, afterwards goes on *serpentining*, and ends by forming many convolutions: next he sees the liver, whose development accompanies that of the stomach and intestines, to which it is subservient: and, lastly, he sees the lung take its form and place, always filled with air, and so transparent that one might believe the animal has, on the two sides of the trunk, two bubbles of air, which gradually dilate and elongate from before, backward.

When the organs of digestion have acquired the size necessary for the exercise of their functions, the curious spectator perceives in the little salamander, whose life hitherto has been purely organic or vegetative, the life of *relation*, or the *animal* life, to begin. At this epoch, the movements of the young animal are no longer automatic, or the result simply of its internal organisation, but they are also the consequence of sensations which the surrounding objects cause it to experience. In truth, it now avoids and removes from those objects from which it dreads inconvenience or pain, and approaches those from which it hopes to receive advantage or pleasure. We see it, at this period, watch the minute insects which it sees swimming in the water, direct its little snout towards them, pursue them with address, and dart upon them with surprising agility. When it is keenly pressed by hunger, it attacks even its comrades, and seeks its nourishment by devouring their gills and tail. The lively pleasure which these interesting scenes afforded me, continues the author, suggested to me at once the idea of making them known to naturalists, by publishing a work on salamanders, similar to that which the celebrated naturalist of Nuremberg, M. Röesel, has given on frogs; and to follow, in every point, the example of that celebrated writer, I resolved to engrave the plates myself. To speak truly, however, I hesitated a little before I undertook this task; for having never engraved in my life, I anticipated the difficulties I should encounter, and had little hope of getting out of them with honour, and according to my wish. Reflecting, nevertheless, that engravers, even the most able, when they are set to engrave objects, which they have not them-

selves designed, and of which they have no sort of knowledge, may be compared, in some manner, to those who copy a manuscript, written in a language which they do not comprehend, and who, on that account, suffer to escape from their pen, in almost every line, some error which alters the original, or renders it unintelligible.—Reflecting, I say, on this, I tried to raise myself above my fears, and, listening no longer to any thing but the lively desire I felt of presenting to the eyes of naturalists a faithful image of the interesting spectacle I had contemplated, I set myself to the work with a sort of enthusiasm."

Having made these preliminary remarks, Dr Rusconi proceeds to describe the only two species of aquatic salamander which he has observed in the province in which he resides. These are the little salamander (*Salamandra exigua* of Laurenti), and the flat-tailed salamander (*Salamandra platycauda* of D'Aubenton).

In Plate III. Fig. 1. is represented the male of the little salamander, of its natural size, as he appears in the season of love. The toes of the hind paws, at this period, are furnished with a membrane, spotted with black. The tail is very large, and presents, along its inferior border, a stripe of fine clear red; the superior border is continued even to the shoulders. But these ornaments are only transitory; for, after the season of love, the membrane of the toes disappears, the tail shrinks remarkably, and, at its extremity, is reduced to a fine thread.

In spring, when nature kindles the flame of love in these animals, the male seeks with ardour the female. She, by swimming away, avoids his first approaches; but he pursues her with constancy, and, as soon as she stops, he leaps before her, as if to obstruct her progress. He then bends forward his tail, which he agitates and shakes with surprising quickness, making, at the same time, little incitements to his companion, in order to prepare her for fœcundation; after which, he places himself by her side, and lashes her with his tail.

The female of this species is represented in Fig. 2., at the moment when she is tired with swimming to avoid the male. She now keeps her tail and paws immoveable, and suffers herself to fall gently in the vessel. The male, profiting of this exhaustion of her strength, leaps before her, as already described.

In this species of salamander, the pelvis is attached to the 14th vertebra. M. Cuvier, following Latreille, designates this species by the name of *Salamandre palmipède*; but this denomination, says the author, is improper, inasmuch as it is founded on a character which is neither permanent nor common to the two sexes; and, besides, the feet of the male are not palmated, but lobulated.

Of the other and larger species of salamander (*Salamandra platycauda*), Linnæus, says the author, has made two species, which he designates by particular names; Laurenti has made four, Dufay three, Spallanzani two, and some recent authors not less than six. M. de la Cépède is the only one who, in rejecting the species recognised by Dufay, gave a luminous proof of that fine tact which characterises him. But it is in vain to expect to avoid errors in natural history, when we do not take anatomy for our guide.

The salamanders of this species, when very young, that is to say, soon after their metamorphosis, have a line or streak of fine yellow, bordered with brown and black, which extends from the middle of the head to the extremity of the tail. At this age, we remark, in their exterior conformation, no difference between the male and female; but, in the following spring, the yellow streak disappears entirely from the back of the male, and is replaced by a membranous and serrated crest, which has procured for this species the name of *Salamandra cristata*. Toward the beginning of the autumn of the second year, this membranous crest exhibits, at its base, small yellow spots, which, in extending gradually along the back, terminate by forming anew the streak which had disappeared five or six months before. In the mean time, the membranous crest shrinks; and, before the end of autumn, is changed into a streak, slightly prominent, and of a dull yellow colour. With the return of the fine season of the *third* year, the yellow streak disappears; and again the male adorns himself with his crest, which again shrinks remarkably, as soon as the season of love is past. Towards the autumn of this year, only some slight traces of the yellow streak can be perceived, and these disappear for ever with the spring of the fourth year. According to the author's observations, the male is not in a condition to reproduce before the end of the

third year. In the female, the yellow streak enlarges and becomes dull.

Such are the changes which these animals undergo, according to age, sex, and season; but they exhibit many other changes as to colour, which are altogether accidental and fleeting. The author has more than once seen an individual, which was of a pale green above and almost without spots, become brown, and covered with large bluish spots in less than an hour; and these again disappeared, and the animal no longer presented, on the upper surface, but one uniform tint, which was almost black. It is from inattention to the changes in form and colour, arising from difference of age, sex, and season, that so much confusion in the classification of the species of these reptiles has proceeded.

This species of salamander lives always in the water. If sometimes he is met with on land, it is when, from any cause, the place of his abode has been dried up, and he is obliged to go on land in quest of another pond. He never feeds on the lentils in the water, but only on living animals, resembling, in this respect, frogs. The intervals of respiration in these reptiles are more or less long, according to the degree of heat in which they live, and the quantity of nourishment they take. When they hybernate in holes under ground, their tail is rolled up in a spiral form. This species is less vivacious than the preceding. The male, in making his caresses, does not bend his tail forward like the other, and seems, in all respects, to fulfil the views of nature with less ardour and pleasure. The female, when wearied of flying from the male, at length stops, and yields to his caresses, sustaining herself immoveably on the water. The male then approximates his head towards that of the female; and, profiting of her docility, places himself by her side, but somewhat in advance; and, bending his body in a peculiar manner, he begins first to lash the water, and afterwards the sides of the female, with his tail. His anus, at this time, is very prominent and open, and is bristled interiorly with small points of a silvery white hue. After striking the female with his tail two or three times, he separates a little from her, and falls into a sort of drowsy state. He no longer sustains himself on his paws, but extends himself so that his belly is stretched out on the mud, and he seems to have lost the use of his limbs. His tail, how-

ever, is elevated, and makes some slight convulsive movements, but not at all directed by the will of the animal. Even his trunk partakes of slight contractions; and, at length, small *floculi* of thick white mucus are discharged by the anus, and fall to the bottom of the water, in presence of the female. This drowsy state continues only a short time; the animal awakens; begins again to strike the female with his tail; sheds anew the prolific liquor; and, after repeating two or three times, this species of copulation, he abandons his companion altogether. In Fig. 3., the male of this species is represented of the natural size, at the moment in which the prolific fluid is discharged.

During the time the male lashes the female with his tail, she remains immoveable, but at last she puts herself in motion; and, with that slowness which is peculiar to her, goes in search of a plant the most proper for receiving her eggs. It is almost always the *Persicaria* which she chooses. In performing this office, she approaches her head to the borders of a leaf, and, with her snout, turns it in such a way that the lower surface of the leaf, which looked toward the bottom, is made to turn towards her breast; afterwards, with her fore paws, she passes the leaf, thus turned, under her belly; then seizes it with her hind paws, and conducts it beneath the anus, having care, at the same time, to fold it, and form with it an angle, the opening of which is directed towards the tail. The egg, in escaping from the anus, would necessarily pass through the middle of the angle formed by the leaf, but it is stopped in its fall by the salamander, who, by means of her hind feet, shuts up immediately this angle, and thus forms in the leaf a fold in which the egg is contained. The egg, notwithstanding, would fall to the bottom of the water when the feet were removed; but the salamander, before quitting the leaf, presses its folds so well with her hind feet, that the glue with which the envelope of the egg is besmeared, spreading itself a little, by means of this pressure, on the two internal surfaces of the leaf, prevents then the folds from opening. When several eggs have been laid in this manner, the animal remains tranquil in the vessel until another male comes to caress her, as before. How long the period of laying continued, the author does not know: but he has found eggs as early as the middle of April and as late as the middle of July. In Fig. 4., a female

of this species is represented in the act of laying her egg; and the letter *a* of the same figure shews a leaf folded down, in which an egg has been laid.

The egg thus deposited on the leaf, is committed to Nature to carry forward its several stages of evolution; and these the author next proceeds to describe. In the plate, the whole series of appearances is exhibited as they occur in the egg of the *Salamandra platycauda*; and, in order to make known the different epochs of development, and the intervals between them, by a simple inspection of the plate, without recurring to the explanation, the figures are marked, in succession, by the dates of the days in which the designs have been made. Thus the figure marked 23d April, exhibits the egg of its natural size, and the figure below it, the same egg magnified. It was collected immediately after being deposited, and kept always in the water, and on its proper leaf. During the period of observation, the temperature of the water varied from 22° to 27° of the Centigrade scale. The globule in the centre is white, with a tint of yellow: it is surrounded by a glairy matter, to which it is no where attached; so that it is able to move freely in every direction: its envelope is membranous, transparent as glass, and covered with a kind of very limpid viscid matter. If one of these eggs, with its envelope, be placed on a dish, and if, with the point of a fine brush, its envelope be turned, so that the upper part shall be made to look downward, the globule presently turns on its axis, in such a way that it presents anew the surface which was at first uppermost, which proves that its density is not uniform. This phenomenon is still more readily seen in the eggs of the *Salamandra exigua*, because they are brown on one side and white on the other. If, instead of turning the egg, we elevate one of its ends, so that its longitudinal diameter shall be perpendicular to the horizon, the globule, which was in the middle, falls to the bottom of the glairy matter, which demonstrates that the specific gravity of that matter is less than that of the globule.

Fig. 26th April exhibits the changes which the globule has undergone in the short space of three days. Examining it with the microscope, one suspects already what are the parts of the embryo which become, in the sequel, the belly, the head, and the tail. At first the globule enlarges, then elongates, and its

surface, which was smooth, presents some small eminences. If it has not been fæcundated, or has lost its prolific virtue, it enlarges, during the first days, the same as before, but afterwards changes, so as to resemble a vesicle half filled with water; and, when this appearance comes on, the egg has lost its vitality.

By the 28th, that is, by the fifth day, the embryo has become so much elongated, that, its envelope being short, it is obliged to bend itself. The parts forming the abdomen, head, and tail, are now easily recognized; and, nearer its larger extremity, which is the head, we remark small eminences which we recognize as the rudiments of its gills and fore paws.

By the 30th of April, all the parts above enumerated are more apparent. In the concave part of the embryo, and towards its larger extremity, we observe a small furrow which separates the head from the abdomen, and we see distinctly, along its convex border, the rudiments of the spine.

2d May.—The embryo has now changed its position. Its tail has already the form of an oar. As yet, there is no appearance either of mouth or of eyes: we remark only, towards the extremity of the head, small blackish points, and a slight degree of contraction between the rudiments of the gills and those of the fore paws, which distinguish the head from the chest. It is now that the development of the embryo begins to possess interest. Hitherto the changes of form have nearly resembled those of a seed cast into the water; but at this period, the observer will see the little embryo exhibit motion, array itself in colours which render it agreeable to the view, and he will also see the beatings of its heart. But this period, although the most amusing to the naturalist, is the most dangerous for the embryo; for almost half the embryos, whose development the author has watched, have died at this period, or a little after.

3d May.—The embryo in the last 24 hours has changed its position three or four times. In that it now has, it shews us all the upper part of its body, which is sown with little blackish spots, disposed longitudinally, and forming two bands, which extend from the head to the tail. On the side of the head, and before the two eminences which are the rudiments of the fore-paws, we observe filaments, to the number of four on each side. The two former are not gills, as some authors would have

us to believe, but they are two organs of station, which I shall designate by the name of claspers or hooks, *(crochets)*, because they are analogous to the two hooks, which we observe below the head of the embryos of the green aquatic frog, by means of which those embryos attach themselves to the leaves of the lentils and remain suspended.

4th May.—The changes of position are now more frequent. In that now assumed, the embryo presents the lower part of his head and trunk, which is white, drawing a little on green. On its chest, between the gills of the two sides, exactly where the pulsations of the heart are seen, we remark some small irregular blackish spots. Anterior to the two hooks or claspers, we see also other blackish spots, which are the junction of the two bands that run along the back, and were seen in the preceding figure. In the gills, as yet consisting only of a single filament, without leaflets, and as transparent as glass, we see already the circulation of the blood, which is very simple, and performed by a single curved vessel. The blood is white, and is distinctly visible if the embryo be put on a watch-glass, and this glass be placed over the opening of a box, whose bottom and sides are blackened. The two hooks, in front of the gills, are elongated; they are larger towards their extremity than at their origin, and are bent so that their convex side is turned upward. The sides of the embryo are studded with little spots of deep green, which form two irregular bands that extend from the fore-paws to the extremity of the abdomen.

5th May.—We now begin to see obscure traces of the eyes. On the two longest gills, the rudiments of two leaflets are to be seen. The changes of position are now made with surprising rapidity. The embryo seems greatly constrained within his little cell. He tries to extend himself in a straight line, and consequently exerts continually a strong pressure against the walls of his envelope. The membrane, which forms the superior border of the tail, extends itself, diminishing in its progress even to the shoulders.

6th May.—The young salamander of the natural size, just escaped from his envelope, as seen from above. In the progress of its enlargement, the embryo gradually dilates the envelope; but this dilatation has its limits, and the little animal at length

forces its way out by tearing it: If it be now lightly touched, it makes lateral movements with its trunk and tail, and is thus enabled to swim; but in a mode different from that which it afterwards employs. Its movements indeed, at this period, may be said to be purely automatic: it strikes sometimes against a leaf, sometimes against the sides of the vessel, and as soon as it does this, it attaches itself to the body struck, and remains suspended, by means of its two hooks, the extremities of which are covered with a viscous matter. One might imagine that the young salamander sleeps continually at this period; for if the vessel be slightly shaken, its body oscillates with the movements of the water, just as any inanimate body would do. It now passes some hours without moving: Afterwards, without any evident external cause, it makes some lateral movements with its tail; swims in its own manner; and reattaching itself anew to some other leaf, it continues to sleep, or remains in absolute repose for half a day or more. If, while making these lateral movements, it meets with no substance to which it can attach itself, it falls then to the bottom of the water, where it continues in repose, lying sometimes on its side, sometimes on its belly. Its eyes are scarcely as yet designed; they form two prominences on the sides of the head. Its mouth is so slightly traced that it requires attention in the observer to perceive it; it is indicated only by a very slight transverse depression, situated beneath the head, and between the two prominences formed by the eyes, and in the middle of the space between the anterior border of the head, and the origin of the neck. Its fore-paws, protruding like two buds, begin to separate from the gills; these gills are gradually furnished with small leaflets. At this period, the life of the salamander may be considered purely *organic*.

In Fig. *a*, the same salamander is seen from below, with the aid of the microscope; *b b*, the two prominences formed by the globes of the eyes, between which is the slight depression which becomes afterwards the mouth; *c*, the hook of the right side; *d*, the gills of the same side; *e*, the rudiment of the fore paw of the same side; *f*, the same animal seen in profile; *g*, the same viewed from above.

18*th May.*—The same animal, of its natural size, seen from above, exhibiting the changes in the external form of the

young tadpole, twelve days after its escape from its envelope. Its fore paws are now lengthened; and, dividing at their extremity, take the form of a bicuspid tooth, the two tubercles of which elongate in their turn and change into two toes. The eyes are now disclosed, the pupil appearing of a fine black, and the iris of a silvery white, speckled with many colours. The yellow colour of the back of the little salamander is changed into a green: the gills, which exhibited only the first rudiments of leaves, are now clothed with little leaflets, in which a red blood circulates. The transverse depression between the eyes, which marked the place of the mouth, is enlarged, and, in curving itself, has formed a mouth very large, the extremities of which extend, on the sides of the head, even to the eyes; the head, which was very narrow at its back part, has enlarged greatly near the origin of the gills; the two hooks have shortened by degrees, and almost entirely disappeared: Lastly, the body, which was very opake, has gradually become diaphanous, and to such a degree, that the observer, without injury to the life of the animal, is able to see the dilatations of the heart, and to examine, through the walls of the abdominal cavity, the form and position of the viscera contained within it.

These changes, however, are not the only ones which occur during this space of time: many others go on within, which have endowed the little animal with the instincts and the manners proper to its kind. Its sluggishness has vanished, and it displays the habits which accompany it through life. It loves to keep near the surface of the water, conceals itself beneath the leaves, or swims with surprising quickness. While floating tranquilly near the surface, if any little aquatic insect pass before it, immediately it directs towards it its snout, pursues it slowly, and, as soon as it gets within reach, darts upon it like an arrow, and swallows it. In a word, the salamander, which possessed before only a life purely organic, enjoys now a life of relation; that is to say, an *animal* life.

Fig. *a*, the same animal seen from above with the microscope; *b*, the same seen in profile; *c*, another salamander of the same age (twelve days), opened below, as seen by the microscope; in which *d* indicates the arches of the gills of the right side, as they appear through the skin; *e*, the liver;

f, the stomach; *g*, the intestinal canal; *h*, the lung of the left side.

28th May.—The same salamander, of the natural size, seen from above. It is about this period that the hind paws begin to appear; the fore paws have acquired their perfect development, and are long in proportion to the trunk, as is more distinctly seen in the microscopic representation of it, fig. *a.* Without entering into minute details of the changes which have occurred in the ten days elapsed, and which an inspection of the figures will sufficiently illustrate, the author proceeds to observe, 1*st*, That, at this epoch, we begin to see, on the two sides of the trunk, with the aid of the microscope, two lines of small salient points or excrescences, which extend from the axils to the extremity of the abdomen. 2*dly*, That the walls of the abdomen have not colour in themselves, but that they present the colours of the insects on which the animal has fed. 3*dly*, That the changes of colour from yellow to green, which occur during the growth of the tadpole, are purely accidental, and begin immediately after its escape from the egg. 4*thly*, That the toes, which are most interior, first push forth, as well in the hind as in the fore feet. 5*thly*, That the *pierre amylacée* of the organ of hearing, is, at this period, formed, and is visible through the cranium and skin that cover it. 6*thly*, That at this epoch, and even sooner, the animal begins to expel air from his mouth.

12th June.—The same salamander seen from above, of its natural size, and also in profile (*a*), when magnified. The hind paws have almost attained their development, but as yet the fifth toe is wanting; the lungs extend only about half way down the trunk, and are visible through the walls of the abdomen; the gills, which are longest, have nearly twenty leaflets; they had only thirteen or fourteen ten days before.

18th July.—The same salamander, now arrived at the maturity of its tadpole or larva state. It is represented at the moment in which it watches a little slug, to ascertain its living state; for neither salamanders nor frogs ever fall on their prey, till after having seen it give signs of life.

On this day, says the author, the gills of this tadpole appeared a little less long than on the day before; whence he suspected it was about ready to pass to the state of the per-

fect salamander, and under this idea the design was made. The next day confirmed these suspicions; for the leaflets or fringes, which formed the extremities of each gill, were already obliterated, and the stem or shaft was sensibly shortened. The shortening and obliteration of these parts proceeded daily, so that, at the end of five days, they were reduced to mere simple buds, covered with a skin continued from the head. While these changes were proceeding in the gills, the duplicature of skin, which covered in part the branchial apertures, became by degrees united to the chest; the sharp membranous crests, which the arches bore externally, were obliterated; the apertures of the ears, which gave issue to the water from the mouth, contracted daily more and more; the membranous crest of the tail, which extended along the back, even to the head, contracted also.

Beside these changes, visible exteriorly, the tadpole experienced others within. The two jaws, especially the lower one, were much ossified, and the teeth of this jaw were so hard, as to give great resistance to the point of a needle. Were we to arrange the different pieces that compose the skeleton of the tadpole, at this period, according to their hardness, the lower jaw would stand first, afterwards the upper one, then the bones of the cranium, the vertebræ, and those of the four limbs. At last, the germ of the salamander, which had been deposited, on the 23d of April, in the form of a little globule, had not, on the 27th of July, the smallest trace, either of gills or of branchial apertures. It respired atmospheric air, and made the greatest efforts to escape from the vessel in which it had been developed. In a word, it had assumed the forms which are proper to its species in the adult state.

Having thus exhibited, in detail, the progressive appearances which present themselves in the evolution and development of the *Salamandra platycauda*, the author next offers to our view a few of the analogous stages through which the other species of salamander (*Salamandra exigua*) passes. The minute globule Fig. 1., represents the egg of its natural size; and the adjoining Fig. *a* the same egg viewed with the microscope; the line which bounds the globule indicates the viscid substance which envelopes it. The eggs of this species are easily distinguished

from those of the other, not only by their smaller size, but by a circular band of a deep brown, which does not divide the little globule into two hemispheres, but extends a little more on one side than the other. On whatever side the envelope is turned, the little globule always presents uppermost that hemisphere which is occupied by the circular band. When the evolution of the germ commences, this band opens on one side, and represents then a line greatly curved, which displays itself by degrees, in proportion as the embryo is developed: one of the extremities of this band becomes the head, and the other the tail. In a word, it is the brown part of the globule which forms the upper part of the future tadpole, and the part which is white the belly of the animal; so that even in the germ, the back is less heavy than the belly.

In Fig. 2. *a*, The embryo is represented of its natural size, just after its escape from its envelope, as seen in profile. It is suspended by means of one of its hooks to a leaf of *Persicaria*. The letter *b* of the same figure, represents the same embryo seen by the microscope. The two bands of deep brown which it exhibits, were those, which, being reunited to two others of the opposite side, formed the circular band of the little globule.

Fig. 3, the same tadpole, seen in profile, of its natural size, near the period of its metamorphosis. The author has not deemed it necessary to give the intermediate stages of development, as they presented nothing peculiar. The development of this species is less subject to accident than the former. In all his observations, not one of this species died during the evolution of the germ. The development of the tadpoles of both species, he adds, is accomplished in our climate in the space of about three months.

Having thus exhibited the appearances in the evolution of these animals, many questions, says the author, will probably occur to the mind of the reader. How is the little embryo nourished during its abode in its envelope? Is it by the glairy matter that surrounds it? How, again, is it nourished after its escape from this envelope? Has it an umbilical cord in the first moments of its evolution? Or rather, is the egg of the salamander the animal itself, under a form a little different from that which it assumes after fecundation? As to the last ques-

tion, the author adheres to the opinion of Spallanzani. With respect to the others, he will confine himself to the facts he observed in relation to those questions, and leave the reader to decide for himself.

In order to compare the changes going on exteriorly with those which might take place within, at the different periods of development, the author collected, on the same day, many eggs of the flat-tailed salamander, which had been mostly laid under his eye. He then put these eggs into two separate vessels—in one vessel, those eggs which should show the exterior changes; in the other, those which he meant to sacrifice, in order to see the changes that go on internally. With these last, he put also some of the eggs of the little salamander, with the view of making comparisons. When the embryo, which he regarded as the type of the exterior changes, had attained to the degree of development indicated in Fig. 3d May, he drew from the other vessel another embryo which was at the same point of development; and after having disengaged him entirely from his envelope, by means of two fine needles provided for the purpose, he placed him altogether alone in another vessel, in which there were no leaves of the *Persicaria* present. Whilst he was tearing the envelope, the embryo moved, and changed his position two or three times; but as soon as he was put into the vessel, he dropped at once, with the body extended, to the bottom of the water, and remained motionless. Three hours after, it was observed that he had changed his position, and turned himself on the opposite side. In a word, he changed from time to time his position, as the embryos, while yet retained in their envelopes, do; and his development continued, like theirs, without presenting any difference.

In proportion as the embryo of the salamander increases in size, its envelope becomes freed from the viscid matter with which it was besmeared, is dilated, and at length thinned to such a degree, that when the salamander is hatched, this membrane is reduced to an extremely fine pellicle. During its dilatation, the surrounding water passes through the walls of the membrane as through a filter; so that the envelope, in all the stages of evolution, is always stretched, and filled with a very limpid fluid. The author could never see the smallest appearance of

an umbilical cord, nor any thing that could lead him to suspect its existence. Having a desire to seize the moment in which the viscera of the abdomen begin to appear, he opened an embryo longitudinally, just at the period of hatching; but the eye, though aided by a glass, could not discover in it the slightest trace of organization: the whole appeared to consist of an uniform jelly. He repeated this experiment on another embryo which he cut transversely, after having placed it for fifteen minutes in alcohol; but with the exception of the vertebræ, he could not perceive, even with the microscope, any trace of organization. Continuing this research on other embryos which were hatched, he satisfied himself that the organs of digestion begin to form two or three days after the embryo has escaped from its envelope; and that they do not attain to that degree of development, necessary to the exercise of their functions, until about the tenth day. He has seen these organs to be developed at the same time that the mouth is formed, and the two hooks are obliterated. At this period, however, they are far from having reached their complete development, as the reader may see by examining the design annexed to the Fig. *c*, 18th May, which represents a young salamander, in which the belly has been opened twelve days after its escape from its envelope, as seen by the microscope. In examining this design, he will see that the intestinal canal extends, almost in a straight line, from one end of the abdomen to the other; while, in adult salamanders, and even tadpoles, when near the period of transformation, this canal forms three or four great foldings. He will see, also, that the liver and lungs are proportionally very small. In anatomising this young animal, the author could perceive no traces of the *corps frangés*, nor of the kidneys, nor of the urinary bladder. He remarked, however, that the vertebræ and the lower jaw were the only parts of the skeleton which, at this period, had acquired a cartilaginous consistence.

In a future communication, I shall exhibit a fuller account of the anatomy of this animal in its tadpole state, and of the phenomena which accompany its transformation into the perfect salamander—drawn partly from the present memoir, but more especially from one published by the same author in 1817.

D. E.

Art. XII.—*Outlines of a Geological Comparative view of the South-west and North of France, and the South of Germany.* By Ami Boue', M.D., Member of the Wernerian Natural History Society, &c. *

Dear Sir,

I HAVE prepared a very full account of my late geological observations, which I hope to publish on my return from Transylvania. In the mean time, as many of the facts are of importance, and do not agree with the statements of Mr Buckland, and other English geologists, I send the following outline for your information, &c. &c. I remain your affectionate pupil,

Vienna, 24*th Feb.* 1823. Ami Boue'.

To Professor Jameson, Edinburgh.

Since the comparatively recent period at which Geology began to assume the form of a science, it has been cultivated with assiduity and success, insomuch that at the present day we may be said to possess a general knowledge of almost every portion of Europe; but in order to render this knowledge complete and satisfactory, it is necessary to review the facts adduced, to compare the phenomena exhibited in different countries, and to state the result with accuracy and precision. For this purpose the travelling geologist must perform his journeys after a determinate plan, and not run about at random, as it were, from one district to another. Those, in the mean time, who are stationary in particular places, must give us minute details of their neighbourhood, endeavour to make their observations coincide with the general results obtained by the other class of geologists, and not be foolish enough to imagine, that they themselves individually are surrounded by a world entirely different from the rest of the surface of the earth, or to regulate, according to the supposed structure of their small corner, all the other parts of the crust of our planet. Such are the ideas which have directed me in my travels:

* Read before the Wernerian Society, April 15. 1823.

to acquire a perfect knowledge of the whole of the flœtz and tertiary formations, and to derive clear ideas of the structure of the secondary rocks of the Alps, seemed to be, in this period of the science, the most important desiderata; and to arrive at these results, no country held out so many hopes as the south of Germany and France; the truth of which presumption will be shown by my narrative.

The *geological structure of France* is much more simple than that of Germany. A great elevated range of slaty and primary hills occupies the central point of that country (the limits of which see in Omalius d'Halloy's Map of France). Around this kind of island are arranged *three great secondary basins*; one called the South-eastern or Mediterranean, the second the Oceanic or South-western, and the third the Northern. The first lies between the Alps and the mountains of the Vivarais and Lozere; the second between the Pyrenees and the hills of La Vendée, the Limosin and La Montagne Noire: the third between the chain of Bretagne and Cotentin, that of Auvergne, the Vosges and Ardennes. These three basins communicate with each other; the south-western with the northern one, by the country around Poictiers; and with the south-eastern by the neighbourhood of Carcassone; and the northern with this last between Vienne and Grenoble. Besides, the northern secondary basin has a free communication with the basins of the northern, middle and southern parts of Germany, and with that of Switzerland and even of Hungary. The southern and more ancient part of the Vosges, the Black Forest, the Odenwald, the great schistose tract of Belgium and Westphalia, the Hartz, the hills around Bohemia with the Thuringerwald, and the central part of the Northern Carpathians, are so many islands of this immense ancient sea; and the Eastern Carpathians are a vast promontory of the great Alpine island.

The *south-western basin* of France is limited on the north by the transition countries of Vendée and Bretagne, which contain here and there masses of *granite*, surrounded by crystalline slates and traversed by *porphyry veins*, (Fond de la Boulogne), exhibiting the same phenomena as in the Erzgebirge. Some small patches of *sandstone of the coal formation*, and *todtliegende*, are also found here and there. In Limosin and Arveisin, we find

nearly the same structure. Granites are still very extensively diffused, crystalline slates (gneiss) in particular are abundant, and here and there the *coal formations* with their *porphyry* are beautifully exposed. (Figeai.) The Pyrenees are *a great transition chain*, very regularly stratified from W.NW. to E.SE. The predominant rocks are slates and greywackes, with their subordinate common indurated quartzose or calcareous slates, and masses of limestone. These last are not only compact, or intermixed with slate, as in Argyleshire, but are often most beautifully crystalline, in short, appear as true primary limestone, and with many interesting minerals imbedded, such as augite (pyroxene), hornblende, (amphibole), macle, grenatite, &c.; yet these in the same bed pass into the compact conchiferous and calcareous rock, and even contain here and there traces of organic beings *. In one or two instances we observe also in these slates a bed of granular gypsum, (Tarascon). Among these great accumulations of transition rocks, there appear large *unstratified masses*, sometimes surrounded by small portions of crystalline slates. These masses consist of *granites*, *sienites*, *serpentines*, and *hornblendic (pyroxenic) rocks*. The *granites* occupy the greatest spaces, and are especially associated with *crystalline slates (gneiss, and mica-slate, chiefly feldspathic)*; yet these last pass every where, and most evidently, into the true transition slates, and even alternate with them. (See Palassou.) Similar facts are seen every where, and from this circumstance, Werner established his class of primitive clay-slate,—a class which can no longer be admitted, since all the localities where this deposit ought to exist in Europe contain organic remains. This transition has also led the chief of the Edinburgh School to his idea of the contemporaneous formation of many rocks, which at first were considered as of a very different nature.

The granites of the Pyrenees do not form nuclei, as Werner supposes; but they present themselves in the form of what he would have called immense beds in gneiss. This appearance, however, is not real; for minute examination on a great scale shows that they have all the characters of veins, often here and

* See Palassou's Work, and his three volumes of Memoirs published 1815, 1819, 1821.

there running parallel to the plane of stratification of the slates. This statement, contrary to the opinion of the most learned geologists, is supported by the *limited space of these masses*, by the *existence of innumerable true granite veins*, by the *phenomena exhibited by an infinite number of small granitoid veins*, which are associated with the last, by the *fragments of slate imbedded in the granite*, and the *particular appearances observable in the rocks near the junction of the granite*.

On these different points I may only here observe, that the distinction of two granites in the Pyrenees forms no objection to my ideas; and farther, that the fragments of slate in granite are seen in the Pyrenees not merely in small pieces, but sometimes in immense wedge-shaped masses, or even hillocks, supported by granite. No country exemplifies this more clearly; and the fact explains the imbedded masses of slate in the porphyry of Schemnitz mentioned by Beudant in his Travels in Hungary. The alterations in the condition of the slates near the granite, similar to those near the prophyry of Vendée and the Erzgebirge, are to be seen in the Pyrenees on a great scale. Whoever has seen the beautiful series of granitic veins which cut and sometimes support the granite of Loucrup, Cierp and Massat, will no longer doubt the igneous origin of granite posterior to the slate formation. If the rock named Blaue Kuppe be a clear proof of the truth of the igneous theory respecting basalt, these places shew that the true origin of granite had also been discovered by Hutton: and our respect for the views of this original thinker is increased by observing, that the masses of granular limestone seem to be in close dependence upon the masses of granite. Where these appear, the compact limestone is more or less changed, and in it minerals have been produced, for which we search in vain in the other parts of the slate formation.

But Hutton furnished no explanation of the most difficult point, I mean the *origin of gneiss*, of *crystalline slate, connected with transition slate*. The Pyrenees seem also to afford a hint of this particular process of nature. Gneiss is not, like granite, an igneous product; many objections oppose themselves to such an opinion, and the shelly granular limestone imbedded in the gneiss of the Pyrenees, and its passage into transition slate, seem to render it very improbable. Viewing the crystalline slates

as aggregate fragments of more ancient rocks, or of the first oxidated crust of the earth, might it not be possible that igneous agents had, before, after, and simultaneously, with the granitic eruptions, acted upon the slates, and produced in them a kind of change? Heat and gaseous emanations would have given, especially under strong compression, a kind of igneous liquefaction to slate, similar to that observed by De Dree in his experiments. The elements of the slates having lost a part of their cohesion, caloric and subterraneous emanations would have occupied the void spaces; chemical affinity would have exerted itself within limits fixed by the force of cohesion, and the constituent parts of rocks would have been able to assume, in the liquefaction or slow cooling, an arrangement more or less crystalline, according to the accessary circumstances, without losing much of their primitive slaty structure. This action of chemical affinities, assisted by foreign matter, introduced by a kind of sublimation, would have given rise to a number of species and subspecies of crystalline minerals, disseminated in nests or in small veins, and only a very small number of other minerals would have been posteriorly formed in it, by aqueous infiltration. According to this theory, the subterraneous agents would have been always decreasing in energy from the granites to the basalts, which would depend upon the change that had taken place, during the lapse of time, in the crust of the earth, owing to the want of compression, and the greater mass of solids accumulated upon it.

This hypothesis explains the facts in a manner agreeable with geological, chemical, and physical knowledge. The inequality of these effects would have given rise to arenaceous, or even vegetable deposits, mixed with crystalline (Tarentaise), and explains the passage of crystalline into transition slate. The identity of the materials of these rocks with those of granite; the chemical composition of various subspecies of minerals, minerals being more crystallized in the truly crystalline rocks than in those which are less so; the mutual insertion of various crystals of two different substances; the macle, the scoriaceous surface of minerals (augite, Pyrenees and Scandinavia); the scapolites surrounded with a slaggy crust of augite; the identity of the disseminated minerals in gneiss and granite; the connection

of these two rocks; the nests of calcareous spar, with other minerals; the intermixture of granular and compact limestone; their small veins; the gneiss breccia; and even in part the disturbed situation of the gneiss, &c. are clearly explained, and even support this view. The theory supposes only the destruction of masses, of which we see no traces, as is often the case with the fragments in greywacke.

Very few *sienites* exist in the Pyrenees, but many masses of greenstone (Ophite, Palassou). These hornblendic and epidotic rocks contain small veins of stilbite, and of quartz, and some iron-pyrites and specular iron-ore, &c. Their varieties are very numerous, exhibiting every form between the two extremes, which are that sort of true greenstone called Primitive, and a kind of basaltic hornblendic Clinkstone; they are massive, globular, or rarely irregularly-prismatic. Like the greenstone of the neighbourhood of Edinburgh, they sometimes pass into a green steatitic or serpentine mass. (See Palassou's Memoire sur l'Ophite). Their position is the same with the globular greenstone of the Fichtelgebirge, and the orbicular greenstone of Corsica; they form among the slates large veins often running parallel to the schist; or rather they have filled up crevices, which have happened here and there, upon a certain line of direction. *Serpentines* are rare in the Pyrenees; they seem only to be portions of the greenstone veins, a character which might perhaps distinguish them from the diallage serpentine. *Hornblendic* or *pyroxenic rocks* are also uncommon, and have nearly the same position. At Lherz they form a large column, which, near its contact with the granular limestone, has formed here and there a kind of brecciated mass of augite and limestone.

Old red-sandstone seems to exist in the Pyrenees, and even a deposit analogous to *mountain limestone;* but there is no proper *coal-formation.* The first *flœtz limestone,* of a greenish hue, and compact texture, alternates with arenaceous indurated marly rocks, with vegetable remains; and rarely there are found masses of a kind of *rauchwacke,* with sulphur and bitumen, like that of Bex and Tarnowitz (St. Boen). The *variegated sandstone* or *red marl* is extended all along the base of both sides of the Pyrenees, or in their valleys; it is every where marly and argillaceous, with gypsum and salt-springs, and with salt-deposits in

Spain. As in other countries, it contains beds of *micaceous specular iron-ore* (Bastenes), also *gypsum (Pouillon)*, crystals of *ferruginous quartz* (Hyacinthe de Compostella), and *arragonites*, as in Spain. Some beds of limestone, either compact or identical with the Hartz *roestone*, are seen towards the upper part of the formation (near Dax), and indicate the approach of the *second flœtz limestone* or shell limestone (muschelkalk), which is compact, and to be seen here and there under the Jura limestone. The *third flœtz sandstone*, or *quadersandstein*, forms also an extensive tract along the whole course of the Pyrenees: it is always white or grey, more or less fine grained, marly, and with mica, and contains vegetable remains and marine fossils, together with traces of lignite and hydrate of iron, or brown iron-ore. The *Jura limestone* lies over it, and forms, especially at both extremities of the chain, an extensive tract of country. Some traces of *gryphite limestone* or *lias*, *magnesian Jura limestone*, and *compact limestone, with few beds of oolite*, compose this deposit, in the lower part of which there are traces of lignite (Les Corbieres).

Of all these flœtz formations, the *Jura limestone* only reappears in the northern part of the great south-western secondary basin of France, and covers all the others, excepting a small patch of *zechstein*, and perhaps of *shell-limestone* (muschelkalk), near Figeai and that neighbourhood. All the northern part of Perigord, the southern part of Poitou and the Saintonge, are *Jura limestone*. Here and there some masses of gypsum belonging perhaps to the *red marl*, make their appearance (Rochefort). In the eastern part, the lias and compact limestone abound; in the western, the *compact newer limestone*, the *shelly limestone*, and the *coral rag* or *calcaire à polypiers* (La Rochelle). The enumeration of the beautiful petrifactions of this deposit would not be consistent with the limited nature of this communication: they are various and characteristic; Diceras, Ammonites, Terebratulæ, Cerithia, &c. Upon the Jura deposit there lie upon both sides of the basin, the *iron and green sand formation*, and the *chalk*; the first deposit is most beautifully seen in the Saintonge, and in the departments des Landes. Its component parts are *sand, sandstone, fine and coarse, indurated sandstone*, used for pavements, *ferruginous sandstone, beds of clay, short beds*

of lignites, and of fuci (Isle d'Aix), with siliceous infiltrations, and a particular fossil *resin, like amber*, and nests of *hydrate of iron*, under the form of brown iron-ore, and hæmatite, &c. This is the formation which affords nearly all the iron so actively employed in the Perigord of Poitou. Upon this deposit, which is more or less intermixed with green particles like chlorite, rests the *coarse chalk*, which presents, in Saintonge and elsewhere, some characters different from that part of the chalk of other countries It is a kind of very white, compact, and porous limestone, which soils the hand very little, and is an aggregate of minutely triturated marine organic beings. Yet some larger bodies are found here and there; for instance Serpulites, Caprinites, Ichthyosarcolites, some Pectens and Trigonia, &c. Upon this chalk, without chlorite, repose, on the north side of the basin, the chalk, with flints and siliceous petrifactions, containing Alcyons, Cyclolites, Nummulites, and many Echinites, Flustræ, Gorgoniæ, Madreporæ, &c. Near the Pyrenees the chloritic chalk, with crabs, is more abundant, and the chalk is very much destroyed and buried under the tertiary deposites.

The tertiary basin of the south-west of France contains four formations; the *molasse;* the *coarse marine limestone;* the *fresh water deposit;* and a great *marine marly, and especially arenaceous deposit.* The *molasse* taking the place of the plastic clay of other countries, presents, as in Switzerland, alternations of marls, clay-marls of different colours, with calcareous and micaceous sandstones, and sometimes very *coarse conglomerate*, (nagelfluh). Very few traces of lignite are seen in it, and only in the uppermost part; and in a few instances some remains of marine shells are seen in it (Libourne); but fragments of bones, probably of quadrupeds, exist here and there.

Upon the undulating surface of this formation rests the *coarse marine limestone, (calcaire grossiere)*, as it is distinctly seen all along the Dordogne from Libourne to Blaye. This calcareous deposit is divided into two parts; the *lower compact*, the *upper sandy, and full of the most beautifully preserved shells.* The *compact marine limestone* contains no chlorite, but sometimes quartz-pebbles, and traces of bituminous beds, and even of lignites: it is a white or yellowish stone, more or less porous and indurated,

composed of triturated particles of organic marine bodies; Cerithia, Echinites, &c. are found in it. The other variety is a true *marly sand*, of a greyish or yellowish colour, and containing shells, the species of which can be referred to sixty-three genera of Lamarck, besides many Lunulites, Madrepores, and some remains of Cetacea, and even perhaps of quadrupeds, as of the Mastodon (Dax). These remains are distributed in these *faluns* irregularly, so that some fossils have their particular localities, and then they are very frequent. Many are similar to those of the calcaire grossier of Paris; but many also are like those of the Mediterranean deposits, or are peculiar to the basin. This formation occupies only the western part of the basin; and the middle part (Department de Lot et Garonne, &c.) is occupied by the fresh-water deposit which lies upon the molasse, and indicates its posteriority to the compact marine limestone, by a *curious alternation of a bed of fresh water limestone, with the falun at Saucas*, and by the *intermixture* of Melanopsides, Helices, Planorbes, Neritines, in the upper part of the falun or sandy marl of Dex. These localities are in the place where the water of the fresh-water lake discharged itself into the sea.

The plateaux of *fresh-water limestone*, consist of a thick bed of a *compact white or yellow limestone*, which is without shells, and which in specimens might often be confounded with Jura limestone, although, in the great, the geologist easily discovers in it the characteristic pores and concretionary structure of a lake deposit. The upper part is an ordinary cavernous fresh-water limestone, sometimes a little bituminous, and with the common shells of the Helix, Planorbis, and Lymnæa kinds, and fragments of bones of quadrupeds, (Palootherium). Some veins of barytes exist in the first, and some masses of millstone or coarse flint, similar to the Parisian, are imbedded in it, with fragments of siliceous wood.

Upon this rock there rest *marls* and *argillaceous clay, with nests of cock's-comb gypsum*, (gypsum en crete de coq), and a bed of *marl with large oysters*. At last we find the great *sandy deposits* forming the Landes, and existing over a vast extent of country. It is a pure quartzose sand, cemented here and there by hydrate of iron (Chalosse), and for that reason able only to rear pines and cork-trees. In the Chalosse it is more marly, and

contains nests of a singularly pure clay, and of the mineral called *Lenzinite.* (See *Journal de Physique*, 1822.)

The *alluvial matters* are very abundant upon the base of the Pyrenees. They are divided into *older*, very much above the level of the present rivers; and into *modern*; and consist of pebbles, sand, rolled masses, *marls* with land-shells, like those found in Austria, and of various *tuffaceous calcareous rocks.*

This last *tertiary basin* is distinguished from that of Paris, chiefly by containing molasse instead of plastic clay; by wanting the upper fresh-water deposits; by containing a coarse limestone, sandy above and chloritic below, and by showing scarcely any traces of gypsum.

If these recent formations are different, the comparison of the secondary ones also presents some variations. The chalk in the north of France is not so much destroyed, and forms a whole basin. The *coarse chalk* of both countries differs; but excepting in the great frequency of vegetable remain sand iron deposits in the *ferruginous and green sand* of the south, the northern similar formation is identical with that of Gascony. The *Jura deposit* is far more complete every where in the north of France than in the south; from both sides the lias forms a line (in Normandy, Lorraine and Luxembourg), under the lower oolite and compact limestone; then come the *upper oolite and compact rocks*, and in Normandy the *coral rag, and the other newest beds of the English Jura deposit.*

The *lias* in Lorraine, &c. shows many beds full of nests of hydrate of iron, and gives rise to extensive mining districts, (Haut Maine, Luxembourg). It is separated from the *variegated sandstone*, by some patches of *quadersandstein* at Vic Metz, and especially in Luxembourg, (See Steininger's map). This is a shelly freestone, sometimes pretty coarse. Under it is the shell limestone, *muschelkalk*, or second flœtz limestone, which surrounds nearly the whole of the Vosges, and has all the characters of the German one. Then comes the *variegated sandstone* of Lorraine, with its *gypsum, salt-deposit*, and *subordinate beds of limestone*, compact, or similar to the roggenstein, which indicates the approach of the shell limestone, (*muschelkalk.*)

If Bretagne and La Vendée have a great resemblance to the Pyrenees, the chain of the Vosges is almost entirely different; for

there, we find ourselves in the midst of the greywacke and feldspathic breccia, that characterise some districts of Cumberland and Wales. Porphyries, which are wanting in the Pyrenees, are found here in abundance, and gneiss rarely; yet we find again at Framont, a granular transition limestone near to, or in, a ferruginous porphyry, full of small veins of hydrate of iron, which bring to our remembrance not only the position of the granular limestone of the Pyrenees, but also the limestone, full of small veins of the same iron, near the granitic rock of Vic-dessus. (See Daubuisson.) The rest of the Vosges is a great deposit of *coal-sandstone*, with columns and veins of *porphyry*, and beds of *porphyritic conglomerate*, as in the greywacke. Above it comes an accumulation of *todtliegendes*, under the form of a *porphyritic detritus*, and a *coarse red conglomerate with quartzose rolled masses*, &c., as in the Thuringerwald; and then immediately above it, without the zechstein, which is wanting, or slightly represented somewhere else, the *variegated red quartzose sandstone*, with its *superior marly beds*, lies upon the Vosges as upon the cover of a house. These upper-beds of the variegated sandstone, contain here and there traces of lignite, and impressions of monocotyledones and ferns (Soultz), and some petrifactions of the shell limestone (muschelkalk), which explains the anomaly of the salt-deposit of Gallicia and Marmarosch. (See Beudant).

In the *valley of the Rhine*, above the shell limestone (muschelkalk), are seen on both sides below Strasbourg, some patches of *Jura oölites*, and even of *lias* at Buxweiler; then succeeds the *plastic clay*, with *molasse* and *nagelfluh* beds, and some remains of quadrupeds; then the *coarse marine limestone*, with fresh-water shells in the northern part, and in the southern patches of *fresh-water limestone* (Haguenau Buxweiler), with nearly the same organic remains as the South of France, excepting some Cyclades and Cerithia, like fresh-water univalves. Great *alluvial deposits*, and accumulations of *marl* with land-shells, accompany the Rhine, and hide, at the base of the Kaiserstuhle, a basaltic group, without crater and coulée, and with very few scoriæ; it is an elevated mass, like the trachytic hills and basalts of Eisenach. From a smaller opening have proceeded the rocks of Alt Breisach. The chains on the east of the Rhine consist of the Black Forest, composed of granite and gneiss, and the Oden-

wald principally of newer unstratified rocks, as sienite, granite, porphyry; and hills on both sides of these ranges seem to consist of the two great red arenaceous deposits of the Vosges, which are not, however, separated by the magnesian limestone (zechstein); yet, on the east of the Black Forest, the porphyries have given rise also to some porphyritic detritus, which lies under the coarse red conglomerate, which cannot be confounded with any other, by an observer acquainted with the characters of the old red sandstone, the todliegende, or newer red sandstone, and the red marl.

On the west of these chains, the red marl has been much destroyed, and has given rise to the valley of the Rhine, inclosed between two precipitous ranges of rock; but on the east it is still entire, and forms an extensive tract of country from these to the German Jura chain, (See Keferstein's Map). It abounds in Wirtemberg, and its marls present the same appearances as elsewhere. They contain gypsum, salt-deposits, beds of limestone, and traces of vegetables.

We shall now trace the shell limestone, and shew that by some observers it has been confounded with the Zechstein. It may afford matter of surprise that I should contradict the opinion of so many celebrated men, but the fact is clear, and the confusion has arisen merely from mistake regarding the geognostical position of the Jura limestone. In Swabia, geologists not finding the zechstein, and yet being anxious to recognise a deposit so well known in the north, had naturally, from their not being acquainted with the shell limestone (muschelkalk), taken this deposit for the zechstein, because it lies above what they rightly consider as the todliegende. This base admitted, they naturally believed that the salt-deposit was placed between their zechstein and todliegende, and this salt they rendered subordinate to the zechstein or alpine limestone of Friesleben. Further, they then naturally called the Jura limestone the Shell limestone, (muschelkalk), and the quadersandstein the Red marl. But when it is once acknowledged, what it is impossible to deny, that their shell limestone (muschelkalk) is not the zechstein, but in reality the second flœtz limestone, it then naturally follows that, as every where else, the salt-deposit lies under the great mass of that formation, and alternates with the lower part of it.

The shell limestone (*muschelkalk*) of Wirtemberg or of Wurzburg, is in every respect the same as that of the north of Germany, and above it comes the *quadersandstein*, or third flœtz sandstone, which surrounds the Jura chain, and lies under it. The most interesting parts of this deposit are the environs of Amberg, where it contains short beds of marly rock, with vegetable impressions (Lycopodites), or siliciferous beds, and a kind of coarse tripoli with carpolites. The *lias* lies above it, and alternates with argillaceous and sandy beds: it is a compact marly rock of a greyish colour, or slaty, with Gryphites arcuata, Plagiostomata, Ammonites, Belemnites, Mytiloides, Reptiles, &c., in short, with all the fossils common to the lias and alum-slate of England; so that I would recommend this part of Germany to the study of those English geologists who are inclined to confound the shell limestone (muschelkalk) of Germany with the lias, because the first deposit does not appear to exist, or but very sparingly, in their own country. This formation is also very interesting, from its clay containing masses of brown iron-ore, or hydrate of iron, which are wrought with advantage, and which rarely contain small veins of wavellite, and of oxide of manganese, and are here and there changed by the quantity of marine exuviæ into granular or compact, or even into beautiful crystallized phosphate of iron (Amberg). The well known nests of compact and reniform *phosphorite* are also found in a clay subordinate to the lias of Amberg.

In Wirtemberg, the quadersandstein becomes always thinner as you proceed to the south, and forms patches upon the shell limestone (muschelkalk). Then the shell limestone (muschelkalk), also occupies a narrow line between the red sandstones of the Black Forest and the lias; and, at last, on the Rhine and in Switzerland, this shell limestone (muschelkalk) appears only with its highest parts among the lias and Jura limestone; it is the Rauchgrauer Kalk of Mr Merian.

The German Jura chain forms a great promontory or *digue*, filling up a cavity which rises to the north, and is deepest toward the south. As I have already shown, it consists of five different parts: 1*st*, The lias and its marls, which are the connecting part between the Jura deposit and the quadersandstein;

2dly, The magnesian Jura cavernous mass; *3dly*, The compact and oolitic part; *4thly*, The schistose lithographic part, which is so rich in fishes and crabs; *5thly*, The clay marl with globular iron-ore.

The *magnesian Jura limestone* presents most singular varieties. When it is a congeries of triturated marine bodies, as near Ratisbon, it assumes the appearance of the porous yellow limestone of the Leithagebirge near Vienna in Austria. The petrifactions or fossils of the compact limestone are very abundant. I would recommend to collectors to go to Amberg, which is one of the best places, and where Professor Graf, a gentleman of erudition, and who has travelled much, sells for a trifle all the petrifactions of the neighbourhood.

Chalk is only deposited upon the Jura limestone near Ratisbone, yet the ferruginous marl connects already the two formations; the green sand, and the chloritic chalk with Gryphites, columba Brg. and spirata Schlottheim, form the chief parts of this deposit. A yellowish-brown limestone, with some madrepores, seems to belong also to it; and under the green sand is a coarse quartzose and calcareous conglomerate, and some nests of a good refractory clay (Abach).

In the basin between the Bohmerwaldgebirge and the Black Forest, there are no tertiary deposits, and only fluviatile marls with land shells, and some calcareous tuffa with bones of quadrupeds; yet, in the Jura chain, there exist at Ulm, at Steinheim, and in a great basin near Wallersten, Oettingen, Nordlingen, &c., fresh-water limestone deposits, with the common shells of the genera Lymnæa, Planorbis, Helix, and Paludina. At Steinheim, the deposit is, in its lower part, sandy, and so full of shells that one may collect them in bushels. Basaltic eruptions have, here and there, found means to traverse the Jura chain: they are chiefly tuffa, full of altered pieces of Jura limestone (Urach, Göttingen); they form large veins or columns, and, in some instances, present themselves in the form of veins of basalt, as near Doneschingen. In the Hegau, they form cones of clinkstone; and on the base of the Fichtelgebirge cones or columns of basalt, sometimes with balls of olivine and pieces of granitose porphyritic rocks, reduced to the state of basalt

jasper of Hausmann, similar to the black shelly rocks of Portrush and Skye.

The Bohmerwaldgebirge is a great mass of gneiss, slate and granite. The granite forms in it large masses, or only conical eminences sometimes hidden by the gneiss, or occurs in veins of a more recent origin, and with many beautiful minerals, as tourmaline, dichroite, andalusite, tantalium, &c. The domes of granite are here and there abundantly supplied with kaolin, which is certainly intermixed with much scapolite, either disintegrated or nearly in its primitive state. Even the gneiss often contains kaolin, and many small veins of granite. Specular iron ore and graphite are seen in it, and sometimes most abundantly, so as to seem to occupy the place of mica. According to my speculative views, we see here a long and great action of the subterraneous agents, and the existence of so much iron and graphite is a consequence of this: the first is a produce of sublimation, as in the extinct volcanoes, the latter an alteration of glance-coal or anthracite, in the same way as this substance has been changed by trap in Scotland. This leads to the idea that diamond may have been formed in the same manner, and might also be searched for in gneiss-like rocks, and in granite or sienite, while the grains of platina, like those of titanitic iron, sufficiently indicate their origin from the destruction of granitose unstratified rocks. And here I may remark, that it is a singular circumstance, that the Bavarian travellers in Brasil found the rocks of that country perfectly similar to those we have just mentioned, for almost every specimen of that distant country has its analogous one in Bavaria. Some veins of porphyry exist also in the gneiss of the Bohmerwaldgebirge (Bodenwehr).

The structure of the secondary formations of the Alps has puzzled many geologists; yet, the means of cutting the Gordian knot have been given by Escher, De Buch, Mohs, Lupin, Uttinger, Pantz, Keferstein, &c. The writings of these excellent geologists, together with the judiciously managed travels of M. Buckland, have enabled us at last to acquire a distinct view of this part of the alpine regions. It would be quite useless for me to relate my own observations in this place, were I not of an opinion different from that of Professor Buckland upon the newer deposits of the Alps.

Upon the *old red sandstone* rests the *great alpine calcareous tract*, which belongs to the zechstein or magnesian limestone; it is in great part a magnesian limestone, which presents some varieties of rocks, one of which is rather compact, another somewhat granular, while another is fetid, and some, particularly those in the upper part of the formation, are porous, or present the structure of the rauchwacke (Eisenertz.) In its lower parts there are vast deposits of lead and zinc, in the form of small veins; *bitumen* is found here and there in it; in some places mercury has been collected, which could only come from some bituminous part of this formation, and here and there are found *columns of porphyry* (Hindelong, Geisalp). This grey, or yellowish, or whitish limestone, forms very high hills of at least 7000 or 9000 feet, and its masses very rarely show any traces of stratification. Petrifactions are exceedingly rare in it. It is the Hochgebirgskalk of Escher and Üttinger, and a part of the alpine limestone of Humboldt, Freisleben, De Buch, &c. It is impossible to confound it with any other limestone deposit, for it has not the slaty structure of the transition limestone, nor the petrifactions of the shell limestone (muschelkalk), and, besides, it lies everywhere under the variegated sandstone and salt-formation. This *last formation* presents, in the Alps, as elsewhere, two masses, an arenaceous and a marly. The first is composed of alternations of greywacke-like micaceous sandstone, seldom very coarse, with marls which are of a greyish, brownish, or yellowish colour; in short, not red like the variegated sandstone of Germany, because in the northern part of the Alps there have been no porphyries, to give them the necessary supply of hydrated oxide of iron. These rocks are placed above, and sometimes also below the marly masses, which consist of alternations of various marls, more or less indurated, and of a brown, reddish-brown, blackish, greyish, or greenish colour: they contain gypsum and rock salt. Petrifactions are not seen in this formation, but there are many vegetable remains, often of marine plants (Kahlenberg). This formation, which is distinctly stratified in thin layers, lies between the magnesian limestone and the shell limestone (muschelkalk); and, as elsewhere, the upper part of it often alternates with indurated marl

or limestone, or even with limestone, identical with the shell limestone (muschelkalk), and with flinty concretions. Thus, at Ischel, the marly mass lies between the shell limestone (muschelkalk) and a series of marly and calcareous beds; between Klosternenburg, near Vienna, and Nussdorf, the undulated beds of the deposit contain many limestones, which are here and there traversed by minute ferruginous veins, like the reniform marble of Florence. After this short description, I imagine no one can any longer doubt the identity of this deposit with the red marl. This formation fills up the valleys of the Alps, and forms only in the eastern part, and in the Carpathians, most extensive ranges of hills, like the Spessart. It is the *grès houiller* of Beudant, and of my former memoir *.

As this deposit lies upon a very irregular surface, it forms, as elsewhere, many undulations, and affords the first origin of the undulated stratification of the hills of shell limestone (*muschelkalk*), which overlie this formation. The *alpine* shell limestone (*muschelkalk*) is a compact limestone, of a whitish, greyish, yellowish, brownish, and rarely blackish or reddish colour. It contains imbedded flinty concretions, and is traversed by many small veins of calcareous spar, which are generally totally different from those of the transition limestone, and the thin numerous veins of the magnesian limestone, in short, are analogous to those of the shell limestone (muschelkalk). These rocks, which are in some few instances of a particular granular or oolitic structure (roggenstein), afford marbles intermediate between the marbles of the transition limestone, and those of the lias or Jura limestone. They contain many of the same fossils as the shell limestone (muschelkalk) of the north of Germany, Ammonites, Modiola socialis, Nautili, Strombites, Turbinites, fragments of Echini, Madrepores, Tubipores, Alcyons, &c. They form very high hills, composed of thin beds always stratified, which affords a good test to distinguish this limestone from the magnesian, upon which it often lies in patches or hills. It abounds around the salt district, in Austria, Switzerland, Dauphiné; in short, it is a part of the Alpine Limestone of authors.

* Memoir in vol. iv. of the *Memoirs of the Wernerian Society*.

After this description, I need only add, that I see nothing in it of the character of the lias or Jura limestone, as Mr Buckland calls this deposit. Its intimate connection with the salt formation, its situation, its petrifactions, its nature, all shew that it is the shell-limestone formation (muschelkalk), so long neglected, and which now seems to occupy so conspicuous a place in nature. It is probable, that even a great part of the limestone lying upon the Macigno, or variegated sandstone of the Middle Appennines, belongs to the shell limestone (muschelkalk), and not to the Jura limestone. Yet, in contradicting in this manner so intelligent an observer as Buckland, I do not, by any means, consider it impossible that some *patches* of the Jura formation may be situated near, or upon the Alps, in some parts; but in Germany I do not know of any facts which shew the probability of this statement, and so long as Mr Buckland is without a clear idea of the shell limestone (muschelkalk), and of its difference from the lias, at least in Germany and France, he will probably hesitate as to the accuracy of my observations. His chief arguments are derived from the petrifactions; but is it not very natural that the same terebratulæ, or some other similar petrifactions, may exist both in the shell-limestone (muschelkalk), and lias? and until he shew me in the alpine shell-limestone (muschelkalk), the Gryphites, the Ichthyosauri, the Plagiostomata, and shew that it is unconnected with the salt deposit, I cannot adopt his ideas, which seem to me inconsistent with nature.

After having described these different formations in their proper order, and removed the confusion which has arisen from the neglect of the study of petrifactions, the ignorance of the true nature of the south-west part of Germany, and a false analogy, I pass to the next alpine deposit. In Austria alone, there seem very probably to exist some patches of lias, and, perhaps, of quadersandstein. The *green sand, iron sand, and chalk* are the next deposits. They are seen in Switzerland, in Voralberg, in Allgau, and near Traunstein (See Üttinger and Lupin). These deposites present the same characters as in France, excepting that they rise in hills to the height of 6000 feet above the level of the sea. A coarse quartzose sandstone forms the lowest rock. After it, comes a green spotted, fine,

and sometimes marly sandstone; then chloritic white limestone, and ferruginous sandstones, in which the globules of hydrate of iron are often abundant enough to be wrought (Sonthofen, Kressenberg). With this last alternates a *nummulitic brownish compact limestone*, and then come above all some *chloritic chalky limestone*, and the *greyish chalk marl*. Some thin beds of clay, which are sometimes bituminous, are interstratified with these masses; even some few pieces of lignite and *bitumen* have been found in the ferruginous sandstone, and also rarely the same *fossil resin* as in France. Petrifactions are abundantly distributed in this formation, and can be referred to twenty-two genera of Lamarck's shells, as Belemnites, Cones, Murices, &c. There are Ananchites, Serpulites, and crabs, as in France and Hanover. Schlotheim has described nearly all these petrifactions as coming from Bergen and Coburg.

The *great tertiary basin* of Bavaria and Swabia presents two regions, the Southern and the Northern. In the southern, the molasse, and nagelfluh limestone abound; and in the northern, sandstone, and less quartzose nagelfluh, in which green particles are visible, and the formation is capped with a thin covering of chloritose *course marine limestone* (Eckmuhl). In the south, the lower part of the molasse deposit is more compact and calcareous, and in its upper part becomes more marly, and finer in the grain. Here and there are deposits of lignite with palmacites; and fresh-water shells, Planorbes (Ammonites of Flurl), Lymneæ, Mytili? Cyrenes, Anodonta, and Cerithia like fresh-water univalves, have been deposited in cavities of the molasse, by alpine debacles of lakes and rivers.

Local deposits from the waters of springs, of *Calcareous Tuffa*, with many land and marsh shells, Lymneæ, Planorbes, Helices, Paludinæ, are seen here and there, and seem to have been formed, in part, during the formation of the great alluvium which covers the molasse, and forms especially the soil of the middle plains of Bavaria. Others are still forming, but they do not present the particular stratified structure of these tuffas called *travertino*.

On comparing this deposit with that of Switzerland, we find that it is pretty similar; yet it wants the marine shelly molasse of St Gallen, which evidently belongs to the coarse marine lime-

stone, which exists itself at Lichtensteig, and between Solothurn and Aarau; and, besides, in the southern part of Switzerland, there are marls with gypsum, which seem of a later date than the molasse. Compared with the Austrian and Hungarian tertiary basin, this deposit appears of the same nature only in its lower part, for the whole of the remaining parts of the deposit are wanting in Bavaria.

The classification of the Austrian deposits has proved a matter of much perplexity to those geologists who pay too great attention to petrifactions; and they will be much astonished when they are informed, that, in the chalk, or perhaps newer Jura limestone of the Leithagebirge, there exist imbedded *(not in veins)* bones of the mastodon. Nature often overturns the most beautiful systems! Above this chalky deposit, alternating with some beds of arenaceous rocks or calcareous nagelfluhs, lies the plastic clay, with lignites and fresh-water shells; then comes the blue clay, with marine shells and bones of quadrupeds, as in the plastic clay, and which is as analogous to the coarse marine limestone of Paris, as to the London clay. Above it, are some clay marls, with impressions of leaves belonging to genera of trees still existing in the country; then sand without or with marine shells, and some few *melanopsides*, indicating a similarity to the Montmartre fresh-water gypsum deposit; and after that, sand, marl, and marine coarse limestone, corresponding to the upper marine sand of Paris, and fresh-water spring deposits here and there upon hillocks (see Prevost). Geologists, who classify this deposit in a different manner, because bones of quadrupeds are only found at Paris above it, commit the same error as those observers who take a small corner of the earth for an immutable geological type. Each particular basin has its own peculiarities: this is an axiom in transition, in secondary, and still more in tertiary deposits.

I intend to finish this memoir by a view of the changes which have taken place in the waters of the Bavarian basin. The following are the conclusions at which I have arrived. That country formed, at one time, with Switzerland, the Rhine-Valley, and Austria, part of the immense sea which communicated with the Northern Sea, and the Mediterranean. After the deposition of the chalk formation, this sea became an inland sea, and

no longer communicated with the Mediterranean, or at least only by a channel or subterraneous passage. But this sea, which extended at first to Hungary, has been insensibly separated from the Hungarian and Austrian Basin, and from that of the Rhine and of Switzerland; its saline contents have continually diminished; it has at length become a fresh water lake; its level has insensibly decreased by the deepening of the channel which conveyed its waters to the sea; and, at last, this lake has been converted into a plain with many lakes and islands. The lake has nearly emptied itself; the streams of water of the different basins have sometimes entirely changed their direction, as in the Rhine-Valley; the rivers have begun to occupy their bed nearly as at present; and the original warm climate, through different physical causes, has become temperate. Alluvial matters accumulated in Bavaria from south to north, have given rise to a great many of the changes in the currents of the water at different epochs.

ART. XIII.—*Historical Account of Discoveries respecting the Double Refraction and Polarisation of Light.* (Continued from Vol. viii. p. 256.)

Sect. IV.—*Account of the Experiments of the* ABBÉ HAÜY

THE subject of Double Refraction seems to have excited almost no notice during a long interval which followed the labours of Benjamin Martin.

Towards the end of the last century, the Abbé Haüy began to direct his attention to the kindred subjects of Crystallography and Mineralogy, and to lay the foundation of that beautiful system which has immortalized his name.

Not content with the external examination of mineral bodies, he directed his particular notice to all their physical properties, and thus availed himself of the lights of Natural Philosophy, in giving a scientific form to the science of minerals.

In accomplishing this great event, he was naturally led not only to observe the double refraction of minerals, but to employ it as an essential character in his descriptions; and it was from this cause more than from any other, that the attention of philosophers was recalled to a subject which had almost disappeared from modern physics.

The following are the general views given by this eminent author in his *Traité de Mineralogie*, vol. i. p. 230, which appeared in the year 1801.

"The quantity of double refraction," says he, "or, what is the same thing, the magnitude of the angle formed by the two rays, by means of which the eye sees the two images, varies from one substance to another, all other things being similar, according to the nature of the substances themselves. In *Zircon*, for example, the double refraction is very strong, while it is much less sensible in *Emerald*. Besides, this quantity varies in each substance from different causes. In general it increases or diminishes with the refracting angle, or that which is formed by the two faces through which we look at the object. But there is another cause of variation, which combines itself with the preceding, and which depends on the position of the refracting surfaces, relative to the faces of the primitive form; and such is the influence of this cause, that, with two equal refracting angles differently situated, we may have distances perceptibly unequal between the images of the same object, and there is even a limit where the effect of double refraction becomes *nothing*, that is, when the two images are combined into one.

"This limit takes place in *Quartz* and in *Emerald*, where one of the faces containing the refracting angle is perpendicular to the axis. It takes place in sulphate of barytes, when one of the same faces being parallel to the axis, is at the same time parallel to a plane passing through the long diagonals of the base of its primitive form.

"On this subject I possess only a small number of observations; but it is probable that all the substances which have double refraction, are included in one or other of the two preceding cases, which give the limits of all the positions that the refracting surfaces can have, relative to the primitive form. But, as the position parallel to the axis is variable in its turn between several limits which correspond to the diagonals, and to the sides of the base of the primitive form, it is necessary to know which of these last limits is that which belongs to each substance."

"I shall show, under the article Emerald, how a mistake conducted me to these results; and I confess that there remains still an uncertainty respecting the refraction of some substances,

as I have not had leisure to multiply my researches sufficiently, in order to ascertain if a crystal, which gives only a single image of objects, would produce two after being cut in a particular manner.

"Another observation which will be of some use in generalising the theory of these phenomena, consists in this, that all the substances whose integrant molecule is remarkable by its symmetry, have single refraction. Such are those which have for their primitive form the cube, the regular octohedron, and the rhomboidal dodecahedron.

"Experiments on this object have hitherto been made only on those bodies which are called Stones. I have extended these experiments to several called Salts, and also to inflammable substances, and to metallic substances oxidated and united to other substances, and I have found that there is no class of minerals which does not present bodies endowed with double refraction."

After mentioning the methods which he employed for observing the double refraction, but which are entirely superseded by methods equally simple and much more certain, our author remarks, "That it would be difficult to find a character more prominent than that which is drawn from double refraction, since it belongs to the very essence of the minerals in which it exists;" and that "it is fortunate that we are able, in this way, to supply the disappearance of crystalline forms by a physical observation, and thus to read in a certain degree in the interior of the stone, when its exterior no longer speaks to the eye."

The following is the list of substances which have double refraction, as given by the Abbé Haüy.

Haüy's Table of Doubly Refracting Crystals.

Carbonate of Lime. *Strong.*	Corundum.
Sulphate of Lime.	Euclase. *Strong.*
——— Barytes.	Feldspar.
——— Strontian.	Peridot. *Strong.*
5 Borate of Soda.	15 Mesotype.
Quartz.	Sulphur. *Strong.*
Zircon. *Very strong.*	Mellite.
Cymophane.	Carbonate of Lead.
Topaz.	Sulphate of Iron.
10 Emerald.	20 Arragonite. *Strong.*

Haüy's Table of Crystals with Single Refraction.

Fluate of Lime.	*Amphigene.*
Phosphate of Lime.	*Tourmaline.*
Telesie.	*Axinite.*
Spinelle.	*Disthene.*
5 Garnet.	Sulphuret of Zinc.

In his article on the Double Refraction of Iceland Spar, Haüy gives a detailed account of various experiments, that possess no very particular interest. He demonstrates by experiment the error of Newton's law, which we have already mentioned. (See this *Journal*, vol. iv. p. 129.) He establishes the truth of the Huygenian law; but erroneously remarks, that it accords with observations only within certain limits, and he adopts the physical hypothesis of Newton, that the particles of light have two kinds of poles, on which the Iceland spar exerts a particular action, whose centre is placed in the region of the small solid angle of the crystal.

Observations on Haüy's Experiments.

The only observations which we have to offer on the preceding articles, relates to the remark, that the cubical octahedral, and rhomboido-dodecahedral crystals have single refraction. The only meaning which can be attached to this remark is, that some of these bodies have single refraction, for out of the *ten* crystals which Haüy gives as having only single refraction, there are no fewer than six which belong to none of the above primitive forms, viz. those marked in Italics at the top of this page.

The absolute incompatibility of Haüy's conclusions with his own facts, will appear still more strikingly from his list of transparent crystals, which have the *cube* for their primitive form, viz.

Boracite,	*Analcime,*
Muriate of Soda,	*Scheelin calcaire,*
Amphigene.	*Oxide of Tin,*

every one of which, with the single exception of *Muriate of Soda*, has double refraction.

Believing, therefore, that all these *five* crystals had no double refraction, when they actually possessed it, Haüy deduced the conclusion, that all cubical crystals had single refraction, whereas this property belonged only to *one* out of six. The conclu-

sion, however, is still true, and has been established by more numerous and recent observations, both optical and crystallographical. *Boracite* belongs to the Rhomboidal System of Crystallisation; *Scheelin calcaire* and *Oxide of Tin* to the *Pyramidal System; Amphigene* to the Prismatic System; and *Analcime* to the Composite System. *Muriate of Soda*, therefore, is the only crystal left among the cubical forms to authorise the deduction of our author.

Art. XIV.—*Notice respecting a Polished Flint Celt or Battle-axe, remarkable for its size and workmanship, found at Claremont, the property of* James Nairne, Esq.

We have already had occasion, in the sixth volume of this Journal, p. 357., to notice a very singular Battle-axe or Celt of *pure copper* *, which was found at a depth of about 20 feet below the surface of Ratho bog; and we have now the pleasure of announcing the discovery of one of a very different kind, but much more remarkable, both for its beauty and size.

This singular piece of antiquity was found on the 3d of May last, on the property of James Nairne, Esq. of Claremont, near St Andrew's. It was discovered by Mr Hean, the farmer at Claremont, towards the bottom of a pretty steep bank, about two feet below the natural surface of the ground, imbedded between the soil and the clay. The soil partially adhered to it; but when it was rubbed off, the axe appeared in the highest preservation, and seemed as if it had been newly made.

Its general form and appearance is shown at A B in Plate IV. Fig. 6. It is of a grey or dove colour, with a few returning veins of a darker and a lighter tint. Its substance is decidedly Flint. Its larger end A, is brought to a sharp edge in a very beautiful manner, and the smaller end, though rounded with equal skill, is considerably more blunt. Its extreme length AB is exactly one foot. Its greatest breadth at A is 3 inches; its mean breadth in the middle $2\frac{5}{10}$th inches, and its least breadth

* All the Celts or Battle-axes analysed by Dr Pearson, consisted of Copper and Tin. See the *Phil. Trans.* 1796. vol. 86. p. 395.

1 $\frac{3}{10}$th inch. Its greatest thickness is 1 $\frac{5}{10}$th inch; and its weight is about 1 lb. 14 oz.

One of the most remarkable features in this axe, is the perfection of its form, and the smoothness and polish of its surface. Upon examining it narrowly, however, the substance of the flint seems to have been torn up by the hard powder or stone that has been employed in giving it its final shape, and the artist has not been able either to remove these imperfections of surface, or the short scratches which appear to have been produced in the act of polishing.

As long as antiquaries are at variance respecting the origin of the common Celts or battle-axes made of copper and tin, it would be needless to offer any conjecture respecting the history of the present one. If we suppose, however, what is the most probable opinion, that they were offensive weapons used by the Britons, Gauls, or Celts; there can be little doubt that the present magnificent, and, we venture to say, unique specimen, has belonged to some of the Chiefs of these ancient people.

We understand that a polished stone-axe was found in the Blue Mountains of Jamaica; and it is well known, that similar instruments made of Jade or Axestone, very hard and tough siliceous minerals of a greenish colour, are used by the American Indians, and by the inhabitants of the different islands of the Pacific Ocean.

Dr Pearson informs us that there are many stone implements of British and Celtic origin in the collection of Sir Joseph Banks, but he does not mention whether they are polished, or merely chipped into form like those which have been found in Denmark and in the Shetland Islands.

Such of our readers as may have seen any axes similar to the one now described, will oblige us by a communication on the subject.

Art. XV.—*On the Geognostical Structure of the Appennines.* By Professor Hausmann. Communicated by the Author.

The distinguished Professor of Mineralogy, Hausmann, lately read before the Royal Society of Göttingen, the first part of an

essay on the geognostical structure of the Appennines, of which he has transmitted to us a short abstract, the substance of which we shall now lay before our readers. The first section of the essay contains an account of the physiognomy of the mountains, mountain ranges, and valleys. The *second*, and by far the most extensive and important section, treats of the *internal structure* of the Appennine chain. The greater part of it displays a wonderful uniformity, the predominating rock being a white compact limestone, which shews the same characters in places the most distant from each other. But this uniformity of structure is interrupted in the upper part of the chain, where it is connected with the Alps, and in its southern part in Calabria, where there are considerable displays of older rocks. The lateral chains, in many places, and to a considerable extent on both sides of the great chain, exhibit considerable variety in internal structure and composition; and, hence it is, that transverse sections of the Appennines often display numerous alternations of various rocks; but it differs from many other ranges in this respect, that the oldest formations in those places where they appear along with the newer ones, occur neither in the central parts of the principal chain, nor in the higher parts of those, but on the sides and in comparatively low situations.

No primitive rocks occur in the middle part of the Appennines, their place being taken by those of the transition class. Our author does not give any decided opinion as to the formation of the granite and gneiss met with in some places at a distance from the central chain, as in Tuscany, and in the islands of Giglio and Elba. Granite, gneiss and mica-slate are pretty widely distributed in South-western Calabria, and in the opposite coast of Sicily, and these appear to belong to the primitive class.

The transition formation is not only very widely distributed in Italy, but it also abounds in various subordinate members, some of which are remarkable on account of their structure and rarity. The Appennines of Genoa, Lucca, Modena, and a part of Tuscany, are composed of them. In the southern part of Tuscany, the transition rocks extend from the border of the principal mountain-chain to the hilly land of Sienna, and to the sea coast; and the neighbouring islands are partly composed of

the same rocks. They appear, in some points, in the Abruzzo and in Monte Circeo, and in Calabria, occupying considerable tracts of country, every where resting on primitive rocks. The rock named *Macigno* and *Pietra serena* in the vicinity of Florence, of which the coarse varieties are employed as a building stone, and the finer worked into columns, and various architectural ornaments, agrees in its essential characters with *greywacke.* But this rock occurs not only around Florence and in the neighbouring country of Sienna, but every where in Italy, where transition rocks make their appearance. Our author met with it at the northern foot of the *Bocchetta*, also near to *Carrara and Massa*, and in the Appennines of Lucca. It rises to the height of 6546 feet above the level of the sea, in the Cimone in the Appennines of Modena. The greywacke of Italy does not vary so much in its grain as that of Germany; but, like the German, it occurs sometimes in thick beds, sometimes with a slaty structure, and the latter with *vegetable impressions.*

In the Appennines, as in other countries, clay-slate is the constant attendant of greywacke, with which it frequently alternates. It occurs most frequently in the form of *common clay-slate*, with different colours; sometimes as *roofing-slate*, particularly above *Lavagna*, between Genoa and the Gulph of Spezia, where it is quarried to a great extent, and is exported far and wide under the name *Pietra di Lavagna.*

Flinty slate, with brown, black, and green colours, occurs in different places in beds in the transition-rocks. Hausmann met with it in hills between Massa and Lucca.

Talc-slate occurs more frequently, and in larger masses. Its occurrence along with transition-rocks has hitherto been little attended to, although it appears in the Alps in rocks of the same description. It passes imperceptibly on the one side into clay-slate, and on the other into chlorite-slate. Our author found it in these slates in the hills of the *Bocchetta*, and above *Pietra Santa*, where it dips under the brecciated marble of *Seravezza.* Saussure met with it on the coast between Genoa and Andora. The talc and chlorite are frequently intermixed with quartz, and this compound forms a kind of *oven-stone* (gestellstein), which sometimes passes into true mica-slate. Saussure and Faujas St Fond discovered this latter rock between *Genoa* and

Finale, in conformable and alternating beds with *compact limestone and clay-slate*, from whence we may conclude that this mica-slate belongs truly to the transition formation. Our author also considers it as probable, that the gneiss observed on the same coast by Saussure, is of the same age with the rocks just mentioned, which is not without plausibility, on recollecting that transition-gneiss has been shewn to occur in many parts in the Alps.

Compact limestone occurs very abundantly in alternating beds with the greywacke and clay-slate. Sometimes it appears in great masses, but more frequently in alternating beds with these and other transition-rocks. In this manner it occurs in many places of the Appennines of Genoa, particularly on the rocky coast extending from Genoa to the Gulph of Spezia, where it displays numerous wavings, and also fine sections of its strata. It also occurs on the southern declivity of the Appennines to the neighbourhood of Florence, from whence it extends westwards into Sienna. When the compact limestone comes in contact with the greywacke and clay-slate, it passes more or less completely into these rocks; and in this way, a calcareous clay-slate is formed, which occurs in considerable masses in the upper Appennines, as it does in the Alps.

The stone known in Florence under the name *Pietra forte*, and used as flagstones for the streets, is a limestone, mixed with quartz and mica, which occurs in beds along with the greywacke of that quarter. The grey colour, which is so characteristic of transition limestone, is that which occurs most frequently in the limestone of the Appennines. Many other colours also occur; and of these coloured varieties, one of a brownish-red, and mixed with clay-slate, found in the neighbourhood of Sienna, is used for ornamental purposes. The compact transition limestone of the Appennines contains very few organic remains. Micheli found an ammonite in it; and this rare specimen is now in the cabinet of Professor Targioni Tozzetti at Florence. The most remarkable of all the limestones of the Appennines is the *brecciated*, which occurs in single beds, and in mountain masses of considerable magnitude, as at *Carrara*, *Massa*, and *Scravezza*. The beautiful brecciated marble of Seravezza is of this description. The rock appears as if composed of fragments of limestone, varying in size, also in

shape, being sometimes angular, sometimes rounded, and which are connected together by a calcareous mass, or by another of a different nature. The cemented masses are sometimes compact, sometimes scaly-granular. The cementing mass is either of the same substance as the fragments, or it is a compound of clay-slate and limestone, which is often iron-shot, and not seldom intermixed with scales of talc, by which the rock sometimes inclines to *talc-slate*. The imbedded masses have generally a different colour from the basis or ground in which they are contained. In many varieties, as in the marble of Seravezza, the colours are strongly contrasted; the imbedded masses being white, and the basis brownish. The colouring matter of this cement sometimes penetrates into the imbedded pieces; and sometimes the mass of the one penetrates into the mass of the other, in the form of veins; a fact which, along with many others of a similar description, allows us to infer, that the whole mass of this conglomerated marble is of cotemporaneous formation, and not an aggregate of true fragments.

The granular and foliated limestone or *marble* of the Appennines, may be arranged along with the *brecciated limestone*. The celebrated snow-white statuary marble of Carrara, which has hitherto been considered as of primitive formation, is referred to the transition series by Professor Hausmann. The marble of Carrara occurs along with the brecciated limestone in conformable and partly alternating beds, and passes equally into the brecciated limestone, and into the bounding greywacke; and it is so disposed in regard to these rocks, that the greywacke, along with clay-slate and compact transition limestone, forms the underlying rocks, above which is brecciated limestone, which is covered with a mountain mass partly of compact limestone, partly of marble, which alternate with each other, or are contained in each other. In the neighbourhood of Carrara, there is a considerable stalactitic cave, mentioned by Dante, which agrees, in all its characters, with the limestone caves of the transition limestone of Germany. The marble of Carrara, our author informs us, is flexible when in long and thin plates.

One of the most characteristic of the transition rocks is that named *Gabbro* by M. Von Buch, which comprehends the well known Serpentine, the Gabbro of the Italians, and a crystallized

granular compound of Saussurite and Diallage, which is known in Florence under the name *Granitone*, and to which the late Abbé Haüy gave the name *Euphotide*. Many places in the Appennines shew, what indeed was proved by the elder Targioni Tozetti, that these two rocks are but modifications of the same compound. In the vicinity of Prato and Inpruneta, both rocks occur so intimately combined, as to shew that the serpentine is nothing else than an intimate mixture of diallage and Saussurite, with which asbestus is often intermixed, by which the quantity of magnesia of the rock is increased in quantity, and its hardness diminished. Diallage occurs crystallized, on the junction of the granular and compact rock, imbedded in serpentine. Gabbro has hitherto been considered as a member of the primitive class of rocks. It may occur in other places, along with primitive rocks; but here, in the Appennines, it appears as an undoubted transition rock, of the truth of which Hausmann first convinced himself, on the northern and southern acclivity of the Bocchetta, where serpentine, and the granular compound of diallage and Saussurite, occur in considerable masses in transition clay-slate, which alternates with compact limestone, talc-slate, and greywacke. In the vicinity of Prato, and in many other places in Tuscany, Hausmann observed the greywacke slate, calcareous clay-slate, and limestone, dip under gabbro. Among the different rocks which occur along with gabbro in the Appennines, *jasper* and *limestone* deserve particular notice. The first occurs in the vicinity of Prato, in the form of a bed, under the gabbro, generally of a reddish-brown colour; and there, as in other places, occasionally penetrates into the mass of gabbro. The limestone, particularly in the mountain of Genoa, as in the valley of Polzevera, occurs in alternating beds with the gabbro; and often also completely intermixed with it, appears sometimes compact, sometimes as marble, with white, greenish and reddish colours, and forms mixtures with the serpentine, which resemble some varieties of the *verde antico.* Of this kind is the Polzevera marble, which is worked into so many forms.

The structure of the transition formations, as here given, does not show any general regularity in the succession, although such appears to be the case in particular instances. The direction and dip of the strata vary very much. A general view of the

transition formations of the Appennines, shews a connection with them and those to the south of Mont Blanc. Probably the transition rocks of the Appennines may be considered as a continuation of the newer members of the transition series of that part of the Alps.

The varied nature of the upper Appennines forms a striking contrast with the wonderful uniformity of composition of the other parts. From Tuscany to southern Calabria, where older rocks again appear, the whole range nearly is composed of the same compact limestone which has been hitherto named *Appennine Limestone*. This limestone, which very much resembles the white limestone of the Jura, is nearly of the same pale yellow greyish, and seldom reddish white colours, of the same splintery fracture, in the large, sometimes concheidal, and seldom granular foliated. But it wants the frequent beds of *Roestone*, and the numerous petrifactions of the Jura limestone, of which we seldom meet with traces in the Appennine limestone. Among the few varieties which it exhibits, belong the veins of calc-spar, which often traverse the compact limestone: beds of *marl*, and here and there nests and beds of *flint and hornstone* occur.

Although the Appennine limestone much resembles the Jura limestone, and the analogous limestone on the south side of the Alps, as also that in Istria and Dalmatia; yet it is difficult to determine whether the predominating limestone of the Appennines really belongs to the newer flœtz-formations, to which the white Jura limestone evidently belongs, because there are neither superincumbent formations, nor characteristic petrifactions, to afford data for the solution of this problem. The determination becomes particularly difficult, when we know that there is an uninterrupted transition from the limestone of the transition formation to the Appennine limestone; that even a pale limestone, resembling that of the Appennine series, alternates with other transition rocks, and appears even under the gabbro; and that, on the other hand, in some places, where the transition rocks are wanting, the Appennine limestone has a crystalline character. Such observations might lead us to the conclusion, that all the limestones of the Appennines belong to the transition class. But if we compare the situation of the Appennine limestone, with that of the white limestone on the southern and northern sides of the Alps,

we shall be convinced, that, in the places where the secondary rocks usually interposed between the transition and newer flœtz limestones are wanting, there sometimes occurs a connection, a gradual transition from the old limestone to the newest limestone of the mountain group; as also, that masses in the midst of the younger formation resemble those of the older, and *vice versâ*. If, then, it is difficult, in many places in the Appennines, in the vicinity of the transition rocks, to determine to which formation this or that mass of white limestone is to be referred, we may refer the great portion of it to the *white Jura limestone*, which appears to be one of the most widely distributed of the flœtz rocks. If this view is correct, then a part of the plain of the Po with the Adriatic Sea, is to be considered as a longitudinal valley extending from NW. to SE. in this limestone formation. The principal boundaries of the Italian rocks run in the same direction. The NW. continuation of the line of the white limestone of the Appennines above Bologna, meets with the same limestone of Arona on the Lago Maggiore; the line of the transition formation in Calabria skirts Cape Circeo, and advances with increasing breadth through the southern part of Tuscany to the upper Appennines, and from this onward to the Alps. The line of the primitive rocks begins in Southern Calabria, and in the opposite coast of Sicily; touches either the granite of Giglio and Elba, or, if it belongs to the transition formation, probably the primitive rocks of Capo Corso in Corsica.

Italy is rich in *tertiary* rocks, for most of the promontories and low hills of the Appennine chain, and also considerable tracts of flat country, are composed of them. In general, these rocks are sharply separated from the older formations, with which they come in contact. But sometimes there also occurs a transition from the Appennine limestone into the tertiary masses, as was first observed by Brocchi in the territory of Otranto, where a white limestone prevails, which contains, besides the Ammonites of the white secondary limestone, also numerous petrifactions, which belong only to the tertiary formations. Of these tertiary deposites we can distinguish *more general*, and *more local* formations. To these belong different kinds of *marl*, *clay*, *sandstone*, coarse *conglomerate*, and *a sand*, which is either siliceous or calcareous, and often coloured with hydrate of iron. The first mentioned rocks alternate irregularly with each other,

but the sand is always the newest of the whole. This sand, also the marl, clay, and sandstone, often abound in fossil organic remains, among which are bones of colossal sea and land animals, and hosts of shells, often well preserved, and which have been well drawn and described by Brocchi in his *Conchiologia Fossile subapennina.*

The *calcareous tuffa* and *volcanic tuffa* belong to the more local tertiary formation. The frequent occurrence of the calcareous tuffa on the bottom of the valleys, and on the sides of the Appennines, should not excite surprise, as the greater part of them are of limestone. Probably no country in the world exhibits greater variety in aspect, and more extensive masses of calcareous tuffa, than Italy. Our author attempts to arrange the most important of these according to their relative antiquity. Those varieties which contain sea-shells, he considers as the oldest. To these follow, in order of formation, the *calcareous tuffa*, found in the neighbourhood of Rome and other places, and which is of contemporaneous formation with the volcanic tuffa, as is shewn by their alternation with each other. These, and all the other newer deposites, contain only remains of fresh water shells, and traces of fresh water plants. The considerable masses of calcareous tuffa which cover the volcanic tuffa, and, according to Professor Kayser of Christiania, the remarkable mass of tuffa on which Tivoli is built, appears to be of still more recent origin. Those formations of calcareous tuffa which are daily taking place, form the limit of the series of formations of this interesting substance.

Von Buch has shewn, that this *volcanic tuffa*, although composed of volcanic matters, has been brought into its present situation by water, and deposited from that liquid. Its masses, although considerable, are confined to the south-western side of the Appennines, where it appears in two principal districts, of which the one comprehends the neighbourhood of Rome, and extends southwards towards the Pontine Marshes, and northwards towards *Civita Castellana*, *Viterbo*, to the vicinity of *Bolsena*; the other, which is of less extent, occupies the country around Naples. Besides these, small deposites of volcanic tuffa occur in other places. The tuffa varies in its characters even in the same place; but a principal difference occurs between the Roman and Neapolitan

tuffa in this respect, that, in the one, the Roman, *leucites* more or less decomposed, occur, but are wanting in the other; while, in the Neapolitan tuffa, we can generally observe that the substance of *felspar* has contributed materially to its formation. Where volcanic tuffa occurs along with the more general tertiary formations, it is always newer than these. Of this we can convince ourselves in a most satisfactory manner in the vicinity of Rome, where we observe the sand of *Monte Mario* filled with sea-shells, rise from under volcanic tuffa near to the Vatican.

At the conclusion of the memoir, our author remarks, 1*st*, That the principal chains of the Appennines contain no *true volcanic rocks*, nor rocks of the *trap formation*. 2*d*, That the *true volcanic formations* are principally confined to the south-east side of Italy; that the greatest extent of these occurs in the line of the older rocks, and that only a portion of these, such as *Vesuvius*, the extinct volcanoes of *Nemi* and *Albano*, as also the remarkable stream of lava of *Borghetto*, approach the boundary of the alpine limestone.

Art. XVI.—*Description and Analysis of Sordawalite, a new Mineral from Finland*, by M. G Nordenskiold, Esq.

A black mineral, somewhat like coal in appearance, occurs in the rock on which the church is built, near to the town of Sordawala. From its resembling the black garnet of Swaphawara, in Lapland, analysed by Hisinger, it was regarded as massive Melanite. The following analysis, which I made of it, proves that it is a distinct and new mineral. Its external characters are as follows:

It occurs massive, and without any traces of cleavage. The colour is greenish, or greyish-black. It is as hard as glass. It occurs in a thin bed, and breaks readily in a direction at right angles to the direction of the bed. The fracture is conchoidal; and the lustre vitreous, inclining to semi-metallic. Opaque. Brittle. Specific gravity 2.530.

N. B It becomes reddish on long exposure to the atmosphere.

It is found in a bed, from half an inch to an inch in thickness,

in a primitive track, into which it is seen to pass. Before the blowpipe it changes, although with difficulty, into a blackish globule, which has sometimes externally a metallic lustre; with a little natron it changes into a blackish green globule; with more natron into a rough slaggy mass; and with borax into a green glass. Is partly soluble in muriatic acid.

I found its chemical composition to be as follows:

Silica,	49.40	Magnesia,	10.67
Alumine,	13.80	Phosphoric Acid,	2.68
Peroxide of Iron,	18.17	Water,	4.38
			99.10

It seems therefore to be a *mixture* of

$$\mathrm{M\,S^2} + 2\mathit{fe}\,\mathrm{S^2} + 3\,\mathrm{A\,S^2} \text{ with } \mathrm{M}\ddot{q}\,\dddot{\mathrm{P}} + \mathrm{Z}\,aq.$$

Art. XVII.—*Speculations in regard to the Formation of Opal, Wood-stone, and Diamond.* By Professor Jameson *.

I shall now offer a few observations on the natural history of the Diamond, with the view of shewing that its geognostical distribution and modes of formation are probably more varied than has been generally believed. As opal and hornstone agree in many of their geognostical relations with carbon, the essential ingredient of diamond, we shall first trace the various modes of distribution of these minerals, and then those of the diamond, in order to shew that they have been formed in the same manner, and that all of them appear to be still forming on the surface of the earth, in the newest alluvial formations, and probably even in vegetables.

1. *Opal.*—Opal, which is a hydrate of silica, and eminently distinguished by the beauty of its range of external characters,—occurs in small veins and imbedded portions, in various primitive rocks. But its principal distribution is in rocks of the secondary class, particularly in traps and porphyries. In these it is arranged in veins, drusy cavities, and imbedded masses, and assumes the various forms of precious opal, common opal, semi-

---

* From part 2. of Vol. IV. of the Memoirs of the Wernerian Natural History Society, just published.

opal, wood-opal, and menilite. The menilite and wood-opal are the most modern of these,—the first occurring imbedded in the adhesive slate of the Paris formation, the other in tuffaceous rocks, of the nature of trachyte. The opals are found sometimes so soft, that they can be flattened between the fingers. The alluvial rocks are not without opal, for it is daily forming by deposition, from the waters of various springs, particularly hot springs, as those of Iceland. From the magnitude and abundance of these springs, in many regions of the earth, and the quantity of siliceous matter they deposit, we can form a general estimate of the great quantity of opaline matter formed in this way. We have now traced opal, from the primitive to the newest rocks, thus proving that it is one of those minerals which have an extensive geognostical range, and which are still forming in the mineral kingdom; but one of the most interesting features in its natural history remains to be noticed. I allude to its formation by the organic powers of plants. It is well known to botanists, that silica occurs in considerable abundance in several tribes of plants, and that it communicates to the parts of the plants containing it a considerable degree of hardness. The Bamboo is one of the most remarkable in this respect, as the earth it contains occurs not only in the vegetable structure itself, but is secreted from it, and appears in the joints of the plant, in solid masses, named Tabasheer, and which bear a strong resemblance to opal. We have thus shewn that opal is a formation of primitive, secondary, and alluvial strata; and finally, that it is a product of vegetables.

2. *Hornstone.*—We shall next trace the distribution and formation of hornstone. This mineral, which, in its pure state, is principally composed of silica, occurs in considerable abundance in several primitive rocks. It appears also in rocks of the transition-class, and is associated with different secondary rock formations. Wood, penetrated with hornstone, occurs occasionally in alluvial strata, as in clays and sands of various kinds, and exhibiting such characters, as shew that the petrifaction or penetration of the wood with the hornstone, had taken place in it after it was enveloped in the clays and sands. Like opal, hornstone seems sometimes to be a product of vegetable origin; for the specimen which I now exhibit to the Society is a variety of wood-

stone. This remarkable specimen, which is 18 inches long, 5 inches thick, and 8 inches broad, was torn from the interior of a log of teakwood (*Tectona grandis*), in one of the dock-yards at Calcutta. The carpenters, on sawing the log of teakwood, were arrested in their progress by a hard body, which they found to be interlaced with the fibres of the wood, and, on cutting round, extracted the specimen now on the table. This fact naturally led me to conjecture, that the mass of wood-stone had been secreted by the tree, and that, in this particular case, a greater quantity of silica than usual had been deposited; in short, that this portion of the trunk of the tree had become silicified, thus offering to our observation in vegetables, a case analogous to the ossifications that take place in the animal system. I was further led to suppose, that this wood might contain silica in considerable quantity, as one of its constituent parts, a conjecture which was confirmed by some experiments made by Dr Wollaston. Other woods appear also to contain silica, and these, in all probability, will occasionally have portions of their structure highly impregnated with silica, forming masses which will present the principal characters of petrified wood. Indeed, I think it probable, that some of the petrified woods in cabinets are portions of trees that have been silicified by the living powers of the vegetable, and not trunks or branches which have been petrified or silicified by a mere mineral process.

3. *Diamond.*—Having now shewn that opal and hornstone extend in the series of rock-formations, from the primitive to the newest alluvial rocks, and that both appear to be forming in vegetables of particular kinds, we shall next endeavour to shew that the same is probably the case with the diamond. The diamond, as is well known, is carbon in a pure and highly crystallised state,—and although carbon is a very generally distributed substance, it has hitherto occurred but very sparingly in its pure and crystallised state, or in that of the diamond. Primitive rocks, of almost every description, contain carbon,—either in the state of an acid, forming carbonic acid, as in the carbonates of lime and magnesia,—or in the state of an oxide, as in glance or metallic coal,—or in graphite or black lead, which is also an oxide of carbon, but of a different nature from that in glance-coal, —and, from information lately obtained from India, even carbon,

in its purest state, in the form of diamond, is said to occur imbedded in a conglomerated quartz, subordinate to clay-slate.

Greywacke, and other rocks of the transition class, contain graphite and glance-coal, but hitherto have afforded no traces of the diamond. Graphite and glance-coal occur in considerable beds in formations of the secondary class. The diamond, according to different authors, is met with in trap-tuffas, in sandstone, and in amygdaloids of the secondary series. But the geognostical distribution of this gem does not appear to terminate here, for we are assured by those who have attended to its situation in the earth, that it is found in alluvial beds of clay, not as a secondary deposite, but as an original one; in short, that the diamond continues to form, or to use a more common language, to grow as in some alluvial districts in India. This opinion is not improbable, and nothing more seems to be necessary for the formation of the diamond in such situations, than time, or other favourable circumstances, for allowing portions of the carbonaceous matter in the soil to be reduced to the adamantine state, and afterwards to coalesce, according to the laws of affinity, into the granular and crystallised form,—in short, to form diamond. The gradual formation of calcareous grains, crystals and masses of calcareous spar in clays, of siliceous compounds in similar rocks, appears to be occasioned by the gradual concentration of the calcareous and siliceous particles by some attractive power, in the same manner as we conceive diamonds may have been formed by the concentration of particles of carbon.

The preceding details, in regard to opal and hornstone, naturally lead us to inquire, if it is probable that the diamond, like these substances, is occasionally formed by the powers of vegetation? Reasoning *à priori*, we would say it is much more likely that some plants would produce diamonds, than that they would secrete siliceous matter in a state fit to form opal and hornstone, because diamond is but carbon, the principal constituent part of plants, in a peculiar state; whereas the silica of the opal and hornstone are subordinate ingredients in vegetation. But a direct appeal to the characters of some woods seem to countenance the idea I some years ago suggested in the Society, that vegetables may contain carbonaceous matter approaching to the adamantine state. Certain woods which have

not the gritty feel of those that contain silica, are uncommonly hard, dark-coloured, and take a high polish; these I conjecture, may be somewhat of an adamantine nature. If this should prove to be the case, it would neither be surprising nor unexpected, that such trees may secrete carbon in the adamantine state, which, on being removed from the influence of the living principle of the plant, would, by the power of affinity, form into true diamonds,—just as the silica secreted from the bamboo takes the form of opal, and that from teakwood the characters of hornstone.

The preceding statement, then, seems to give plausibility to the idea, that some sorts of trees may be characterised by the power of forming a mineral matter of the nature of hornstone; that others secrete silica, which assumes the character of opal; while others may possess the power of secreting and forming diamond.

It may be added, that the carbonate of lime, which occurs in all the rock formations, from the primitive granite to the newest alluvial formation, is one of the mineral substances secreted by vegetables. Some lichens and the chara tribe afford remarkable examples of this fact.

ART. XVIII.—*An Account of some Electro-Magnetic Experiments made in the University of Utrecht.* By Dr VAN BEEK, Major-General Baron VAN ZUYLEN, VAN NYEVELT, and Professor G. MOLL. Communicated by the Authors.

IT was stated some time ago, by Professor Seebeck, in some of the French and German scientific journals, that *Antimony*, brought into proper contact with another metal, and *unequally* heated, would cause the magnetic needle to deviate from its meridian. With a view to ascertain this fact, and to investigate whether this property was restricted to antimony, or extended to other metals, the following experiments were made.

1. A parallelopiped of *Antimony* was procured, about fifteen inches long, and one inch square. This bar was prepared by treating crude antimony with sulphate of potash and tartrate of potash. A slip of copper was attached to both ends of the anti-

mony, and bent, as the figure (Fig. 7. Plate IV.) indicates. It was kept in close contact with the antimony by means of copper rings. This bar was laid in the direction of the magnetic meridian. A needle was placed on the antimony, as shewn in the figure, and the ends N and S of the bar were successively heated by a spirit-lamp. When the heat was thus applied to the south end S, the magnetic needle immediately, and strongly, deviated to the *east*. The extent of this deviation depends on the length, mobility, and strength of the needle. We have seen it as much as 68°. When the heat spreads more uniformly through the metal, the deviation decreases, and the needle gradually returns to the magnetic meridian.

Supposing the deviation to the *east* at its maximum, the lamp burning under the end S, facing the south, if then it be removed, and placed under the end N, the deviation to the east will decrease, and it will change into a deviation to the *west*.

In general, if the heat is applied under the *north* end of the bar, the needle will deviate to the *west*.

2. It was then proposed to try whether *cooling* one end of the bar would produce the same effect as heating the other, and the apparatus was disposed as in Fig. 8. The end N was cooled in some frigorific mixture, whilst the end S was kept in the hand. The needle deviated to the *east*, but, of course, not so strongly, as when the difference of temperature of the ends is produced by heating one of them.

3. The apparatus was then replaced as in the first experiment, and both ends heated by a spirit-lamp. No deviation was observed; on removing the lamp under the *south* end, the deviation is to the *west*; and on removing the lamp under the *north* end, that under the south remaining, the deviation is *easterly*.

4. Two bars of antimony were used, and the needle placed between them, as shewn in Fig. 9. If both the ends N and N′ were heated, the needle, placed in C, did not deviate. If the ends N and S′ were heated, the needle deviated to the west. If S and N′ were heated, the deviation is to the east.

5. In this experiment, both ends of the bar of antimony were connected, not by copper, but by zinc, as in Fig. 7. The bent slip of zinc was fastened to the antimony by rings of the former metal. In order to make the experiment succeed, the oxide

must be carefully removed from the place where both metals are in contact. If the end of the bar of antimony turned to the north is heated, the deviation of the needle is westward, but much less than when the conjunctive slip is copper. By these experiments Professor Seebeck's statement is, we presume, fully confirmed.

6. It then became necessary to inquire, whether antimony alone would act in this manner on the needle, or whether any other two metals, joined in the same manner, would produce similar effects. After some trials, the following apparatus was adopted. A thin slip of red copper, of one-fourth of an inch in width, and a similar one of zinc, were bent, as in Fig. 10, CD, being about 8 inches in length. The ends of the two metals were rivetted together at A and B, and the whole placed in the magnetic meridian, and a needle in E. A spirit lamp was applied to the end B, turned to the north, and the needle deviated 10° to the *west*. If the whole was suffered to cool again to the temperature of the atmosphere, and the lamp was applied at A, the needle would deviate to the *east*.

7. The apparatus being inverted, so as to have the zinc above and the copper under the needle, then on heating the part B, turned to the north, the deviation was 10° to the east.

8. The experiment was repeated with silver and zinc, instead of copper and zinc, as in Fig. 10.

The apparatus being thus situated, the deviation was to the *East*, if heat was applied to the end turned to the *North*; and to the *West*, if applied to the end turned to the *South*.

9. It was thus evident that the property mentioned by Professor Seebeck, is not restricted to antimony, but that other metals, properly disposed, will produce the same effects. General Van Zuylen then suggested a different way of applying the heat, and causing the deviation of the needle, by which means the effects were rendered more striking. Slips of copper and zinc were disposed as in Fig. 11. The two ends of both metals were coiled up together, so as to form a spiral of several turns. This spiral was immersed in a cup containing water; and the whole was placed as in Fig. 11. The needle was set upon the zinc. *Sulphuric acid* was then poured into the cup, and the needle deviated to the *westward* as much as 50° or 60°, and some-

times 87°, according to its sensibility. It is quite remarkable, that, in this case, the deviation of the needle is the reverse from what it would have been if the heat *of a lamp* had been applied. From the 6th experiment it is clear that it would have been to the *east;* whilst, by using sulphuric acid and water, it is to the *west,* when the end turned to the south is dipped in the fluid. The chemical action between the acid and the metals, independently of the heat evolved, having such a powerful influence on the results of the experiment, it was deemed necessary to inquire whether *one* metal, with an acid to act upon it, would produce the deviation. With this view, a trial was first made with a metal and an acid, not strongly acting on each other.

10. A slip of copper, perhaps 16 or 18 inches long, was then bent, as in Fig. 12., and the ends coiled up, and brought as close into contact as possible; the whole being, as usual, disposed in the magnetic meridian, the needle being inside the copper, and the coil to the south. If sulphuric acid is added to the water in the cup, there is no deviation of the needle perceptible. But then, if a bar of zinc be immersed in the fluid, and made to touch the copper, the needle deviates 10° or 12° eastward.

11. If, instead of sulphuric acid, nitric be employed, a deviation of the needle to the west is observable, as soon as the acid is added to the water.

12. The bent slip was now made of zinc, in the same manner as it was made of copper in Fig. 12., as in the former experiment. The coil being turned to the south, and sulphuric acid poured into the cup, the effect was very strange. The needle, placed as in Fig. 12., first deviated to the *east,* but soon after turned to the *west.* In that situation it remained for some minutes, and then gradually returned to the magnetic meridian. If a new quantity of acid be added to the fluid, a subsequent deviation is produced, the needle first turning *eastward* and afterwards *westward.* Whilst this deviation took place, a bar of copper was introduced into the fluid, and made to touch the zinc. The needle began irregularly to vacillate, and actually was made to turn round several times on its axis.

13. The same experiment was repeated, but the ends of the zinc were made so as not to touch each other, as in Fig. 13. As soon as the acid is added, there is a slight deviation to the east,

to which succeeds a stronger one to the west. A bar of zinc is now introduced in the fluid, and successively made to touch the ends A and B. When this zinc touches the end A, the deviation increases to the east, but if it touches the end B, the deviation increases to the west. Both ends being joined by the zinc, the deviation is to the west.

Instead of a bar of zinc, another of copper is introduced, and successively made to touch the ends of the zinc. If it touches the end A the deviation is to the west, if it touches the end B the deviation is to the east; if both ends are joined by the copper, the needle wheels about its axis, turning first through the west.

14. The apparatus was then so far altered as to connect both ends of the zinc by a bar of copper. The disposition was as follows:—The ends A and B were united by a bar of copper, C extending between them, as shewn by dotted lines. This part of the apparatus, as in the preceding, was turned to the south, and dipped in water. A thermometer proved the temperature of this water about 56°. When sulphuric acid was added, the needle immediately deviated strongly to the *east*; and, as the temperature augmented to 92°, the deviation became strongly westerly.

15. Instead of zinc, iron was now made use of, and a hoop of 3 or 4 feet long, 2 inches wide, and $\frac{1}{10}$th of an inch thick, was bent, as shewn in Fig. 14.

The plane of this bent hoop was placed in the magnetic meridian, and two needles, one in C, and another in D, were so arranged as to have their directions in the same plane. Sulphuric acid was then poured on the water in the cup, and instantaneously the point of the needle turned 70° to the *east*. Soon after, this deviation decreased, and became as strongly *westerly*, and remained so for several minutes. It then slowly returned to the magnetic meridian. When returned in this situation, *nitric acid* was added to the sulphuric acid water already in the cup. By these means the deviation became 90° to the east, and remained so for a considerable time. Then a lump of zinc was thrown in the acids, and the *easterly* deviation changed to a *westerly*. After all this a piece of copper was introduced, which made the needle turn on its axis. While the needle placed in C was thus deviating, the others in D followed in a contrary di-

rection. Thus, if the needle C deviated to the *east*, the needle D deviated to the *west*. In general the deviation of the exterior needle D was about *one-half* of those of the interior one C. If, for example, C *would* deviate 90° to the *east*, the deviation of D was 45° to the *east*.

16. Finally I subjoin a method of repeating Oersted's experiment in the most simple manner. Baron Van Zuylen took one slip of copper and one of zinc, and twisted the ends C and D together, as in Fig. 15. This part of the metal was dipped in sulphuric acid and water. The other ends A, B, were bent round a needle, placed above the cup containing the fluid. When these ends were made to touch, the needle was immediately disturbed from the magnetic meridian.

I regret that business will prevent me, for some time to come, from prosecuting this matter any farther, nor do I for the present presume to offer any comment on these extraordinary facts. As the experiments require no extensive apparatus, I hope they may be repeated by others, and I shall be happy to learn the result.

UTRECHT, *25th April* 1823.

ART. XIX.—*Description of Mr Perkins's New Steam-Engine, and of the application of his Invention to Engines of the Old Construction.*

WE have already communicated to our readers in the two last Numbers of this Journal, all the authentic information which we could obtain respecting Mr Perkins's new Steam-Engine; and we have used the utmost diligence to obtain such farther information as may, in some measure, gratify that curiosity which these imperfect notices have excited. There never has been in our day an invention which has created such a sensation in the scientific and in the manufacturing world. The steam-engine of Mr Watt had been so long considered as the greatest triumph of art and science, that it was deemed a sort of heresy to regard it as capable of improvement; and, notwithstanding all that has been done by Mr Woolff, and other eminent engineers, the undoubted merit of their engines has scarcely yet been admitted by the public. Under such circumstances, Mr Perkins's claims

were likely to meet with various kinds of opposition. Instead of hailing it as an invention which was to do honour to the age in which we live, and to add a new and powerful arm to British industry, imperfect experiments and confined views were urged against the principle of its construction, the jealousies of rival traders were arrayed against it, imaginary apprehensions of danger were excited, and short-sighted politicians sounded the alarm, that such an invention would precipitate our country from its lofty pre-eminence among the manufacturing nations of the world.

Most of these grounds of opposition have been now removed by direct experiment. Mr Perkins's engine is actually at work. Its operations have been witnessed, and minutely examined by engineers and philosophers of all kinds; and the most unreasonable sceptics have been compelled to acknowledge the justness of its principles, as well as the energy of its operations. The active and inventive mind of Mr Perkins, however, did not remain satisfied with this experiment. He has discovered a method, which we consider equal in value to his new engine, by which he can convey the benefit of his original principle to steam-engines of the old construction; and this has been recently succeeded, we are told, by a most extraordinary discovery, that the same heat may be made to perform its part more than once, in the active operations of the engine.

In order to convey to our readers some idea of these great inventions, we have obtained a drawing, made by M. Montgolfier *jun.*, and given in Plate IV. Fig. 16., which, though it does not represent the actual machine, yet contains such a view of its parts as is necessary for understanding its principle.

The generator, which supplies the place of the boiler in ordinary steam-engines, is a cylinder ABCD, made of gun-metal, which is more tenacious, and less liable to oxidation, than any other. The metal is about three inches thick; and the vessel, containing eight gallons of water, is closed at both ends, with the exception of the five openings for tubes, shewn in the figure. The generator is placed vertically in a cylindrical furnace EF, whose chimney is G, the heat being sustained by a pair of bellows H, wrought by the engine, and conveying its blast in the direction IK to F. A heat of from 400° to 450° of

Fahrenheit is thus applied to the generator, which is entirely filled with water. The valves in the tubes *m*, *n*, which are steel cylinders working in hollow steel-pipes, are loaded, the one with 37, and the other with 35 atmospheres; so that none of them can rise till the heat creates a force greater than the least of these weights.

Let us now suppose, that, by means of the compressing pump L, whose handle M is wrought by the engine, water is forced into the generator; this opens the valve above *n*, loaded with 35 atmospheres, and instantly a portion of the heated and compressed water *flashes* out in the form of steam of high elasticity, and of a temperature of 420°; and communicating by the steam-pipe 2, 2, 2, with the valve-box V, it enters the cylinder PP, lying horizontally, and gives motion to its piston PQ, which performs 200 strokes in a minute, and drives a crank R, which gives a rotatory motion to a fly-wheel, as seen in the figure *. When the eduction-valve is opened, the steam, after having produced its stroke, is carried by the eduction-pipe 3, 3, 3, into the condenser STXV, where it is condensed into water at a temperature of about 320°, and under a pressure of 5 atmospheres; from thence, by the pipe 6, 6, 6, it is drawn into the pump L, whence it is forced along the pipe 4, 4, 4, to the generator, thus performing a complete circuit.

The forcing-pump acts with a pressure exceeding 35 atmospheres; consequently, when the water received in it from the condenser is urged into the generator, it must expel a portion equal to itself in volume: this portion, as above described, flashes instantly into highly elastic steam. The forcing-pump, too, is so contrived as to act with a steady force, and consequently, the expelled water must be driven from the generator in a steady current, and thus steam of a constant elasticity is supplied to produce the power.

Some philosophers are of opinion, that the heat of the portion of water which escapes, is of itself sufficient to maintain the steam at that high degree of heat and elasticity with which it

* The parallel motion represented at PQ, is not the correct one used by Mr Perkins. The piston-rod is connected by a flexible joint, with a sort of carriage with four wheels at each end, and working in a strong horizontal box of steel.

reaches the piston; and, consequently, that this engine is nothing more than a High Pressure Engine. Other persons, however, have supposed, and we confess we are among that number, that the portion of water which escapes, must necessarily carry off a quantity of heat from the adjoining stratum (the temperature of which *may be* thus reduced below the freezing point). But it is more likely, that, in virtue of some new law of the transmission of heat under the combined conditions of elevated temperature and high pressure, while the water, also, is forced to remain in contact with the red hot generator, the whole water in the boiler may be laid under requisition to furnish the discharged fluid with its necessary supply of caloric.

It is almost unnecessary to state, that the motion of the engine is produced by the difference in elasticity between the steam pressing on one side of the piston and that pressing on the other. In the first case, the steam recently produced, acts with a force, say of 500 lb. on the square inch, while that on the weak side, or that communicating with the condenser, acts with only 70, the difference, or 430 lb., being the true power gained.

When there is a surplus of water in the generator, occasioned either by working the forcing pump too violently, or by too vehement a heat, the water will escape by the tube *m* with a valve above, loaded with 37 atmospheres, and will pass by the pipe 5, 5, 5, into the condenser STXV.

In order to explain the ingenious manner in which the pipe 4, 4, 4 supplies the generator with water, we must observe that this pipe communicates with the pump L, which is wrought by the engine. This pump draws the water by the pipe 6, 6, 6, from the condenser STXV, and returns it by the pipe 4, 4, 4; that is to say, when the handle M is drawn up, the water rushes into the cylinder of the forcing pump, through a valve in the pipe 6, 6, 6, opening *into* that cylinder: This valve, of course, instantly closes when the downward stroke of the pump is made, and the water now escapes through a valve opening *outwards*, along 4, 4, 4; thus effectually cutting off all direct or uninterrupted communication between the generator and the condenser. In order to keep the water in the condenser at a pressure of five atmospheres, the blast of the bellows H goes round the condenser STXV; but, when it is not sufficient for this purpose,

cold water is introduced from the reservoir Z, by means of the pipe 7, 7, 7, loaded with five atmospheres.

From the high elasticity of the steam employed in this engine, it has been supposed to be very liable to explosion. This, however, is a vulgar error. Since there is no reservoir of steam exposing a large surface to its expansive force, as in the common high pressure engines, the steam being generated only in sufficient quantity to produce each succeeding stroke of the piston, the ordinary source of danger is entirely removed. But, in order to take away all apprehensions on that subject, the induction pipe 2, 2, 2, in which the steam is actually generated, is made so strong as to sustain an internal force of *four thousand* pounds on the square inch, which is *eight* times more powerful than the actual pressure, viz. 500 pounds on the square inch, with which the engine works. This enormous superabundance of strength is still farther secured by means of the safety-pipe 8, 8, 8, provided with a thin copper "safety-bulb" *a b*, which is made so as to burst at a pressure of 1000 pounds on the square inch. In order to satisfy his friends on this very important point, Mr Perkins has repeatedly urged the power of the steam to such a degree as to burst the copper bulb in their presence. This tube merely rends, or is torn asunder like a piece of paper, and occasions no injury either to the spectators, or to the apparatus; so that we have no hesitation in considering this engine, notwithstanding its tremendous energies, much more safe in its operations than even the common low pressure engine.

The safety tube 8, 8, 8, communicates also with the indicator *c d*, having a dial-plate *c e*, and an index *e f*, which, by means of a suitable contrivance at *v*, *v*, indicates the pressure or number of atmospheres with which the engine is working.

The cylinder and piston PPQ, have been separated from the rest of the engine, for the sake of distinctness. Their proper position, however, will be understood by supposing the two lines 9,9; 9 9 to coincide.

The engine which we have now described, is at present performing actual work in Mr Perkins's manufactory. It is calculated as equal to a ten-horse power, though the cylinder is no more than 2 inches in diameter, and 18 inches long, with a stroke of only 12 inches. Although the space occupied by the engine is not

greater than 6 feet by 8, yet Mr Perkins considers that the apparatus (with the exception of the working cylinder PP, and piston PQ), is perfectly sufficient for a 30-horse engine. When the engine performs full work, it consumes only *two* bushels of coal in the day.

On the application of Mr Perkins's principle to Steam-Engines of the old Construction.

Great as the invention is which we have now described, yet we are disposed to think that the application of the principle to old steam-engines is not less important *. When we consider the enormous capital which is at present embodied in Great Britain in the substantial form of steam-engines, and the admirable elegance and skill with which these noble machines impel and regulate the vast population of wheels and pinions over which they reign, we feel as if some vast innovation were proposed upon our established usages, by the introduction of Mr Perkins's engine. The very idea that these potentates of the mechanical world should be displaced from their thrones; that their strongholds should be dismantled; their palaces demolished, and their whole affairs placed under a more economical management, is somewhat startling to those who dread change, and admire institutions that both work and wear well. Mr Perkins, however, has saved them from such a degradation. He has allowed them to retain all their honours and privileges, and proposes only to invigorate them with fresh influence and power.

In this new system, *the old engines, with their boilers, are retained unaltered.* The furnaces alone are removed. Mr Perkins constructs a generator consisting of three horizontal tubes of gun-metal, connected together, filled with water, and supplied with water from a forcing-pump, as in his own engine. This generator is exposed to heat in an analogous manner, so that, by means of a loaded valve, which opens and shuts, the red hot fluid may be constrained till forced out of the generator into the water in the boilers of Bolton and Watt. By this means, as much low pressure steam of four pounds on the square

* This invention appears to have been fully established by direct experiment, whereas the *new engine*, with all its great promise, is still only undergoing trial.

inch may be generated by *one* bushel of coals, as could be produced in the old engine by *nine* bushels. This most important result, was obtained by actual experiment.

Since these great improvements have been effected, Mr Perkins has made a discovery that seems, in its practical importance, to surpass them all. He now entirely dispenses with the use of the condenser, and works the engine against the atmosphere alone; and by methods with which we are not acquainted, and which indeed it would not be prudent for him to disclose at present, he is enabled *to arrest the heat after it has performed its mechanical functions, and actually pump it back to the generator, to unite with a fresh portion of water, and renew its useful labours.* In an operation like this, a considerable portion of the heat must still be lost, but the wonder is that any should be saved; and we venture to say, that the most sanguine speculator on the omnipotence of the steam-engine, never dared even to imagine the possibility of such an invention.

We are well aware, that, in announcing this discovery, we are exposing ourselves to the criticisms of those whose belief is naturally limited by their own experience; but it is satisfactory to know, that Captain Basil Hall, (whose account of Mr Perkins's discoveries and inventions, as delivered before the Royal Society of Edinburgh, gave such universal satisfaction,) has been entrusted with Mr Perkins's discovery, and that he speaks confidently of the soundness of its principles, as well as the practicability of its application *.

We cannot quit this subject, without congratulating the country on the brilliant prospects with which these inventions promise to invest all our national concerns. At any period of the history of British industry, they must have excited the highest expectations; but, originating as they have done, when our commerce, our manufactures, and our agriculture, the three stars of our national prosperity, have just passed the

* After the 10th June, Mr Perkins, whose address is Perkins and Company, 41. Water Lane, Fleet Street, is ready to take orders for his New Engines, and his apparatus for producing low pressure steam for working the ordinary engines. The price, we believe, of the new engine, is only half that of Bolton and Watt's, with *one-third* of the savings of fuel for a period of years, which we have not heard stated.

lowest point of their orbit, and quitted, we trust for long, the scene of their disturbing forces, we cannot but hail them with the liveliest enthusiasm, and regard them as contributing, to ensure the pre-eminence of our industry, to augment the wealth and resources of the nation, and, by giving employment to idle hands, and direction to idle minds, to secure the integrity and the permanence of our national institutions *.

Art. XX.—*Abstract of Experiments on the Fusion of Plumbago, Anthracite, and the Diamond* †. By Professor Silliman.

Having succeeded in fusing and volatilising charcoal by Dr Hare's Galvanic Deflagrator, Professor Silliman applied the same powerful instrument to plumbago, and subjected anthracite, and the diamond, to the action of the oxy-hydrogen blowpipe.

"From a piece," says he, "of very fine plumbago, from Carolina, I sawed small parallelopipeds, about one-eighth of an inch in diameter, and from three-fourths of an inch to one inch and a quarter in length: these were sharpened at one end, and one of them was employed to point one pole of the deflagrator, while the other was terminated by prepared charcoal. The best were obtained when the plumbago was connected with the copper, and prepared charcoal with the zinc pole. The spark was vivid, and globules of melted plumbago could be discerned, even in the midst of the ignition, *forming* and *formed* upon the edges of the focus of heat. In this region also, there was a bright scintillation, evidently owing to combustion, which went on where air had free access, but was prevented by the vapour of carbon, which occupied the highly luminous region of the focus, between the poles, and of the direct route between them. Just on and beyond the confines of the ignited portion of the plumbago, there was formed a belt of a reddish-brown colour, a quarter of an

---

* It is due to the truth and candour of philosophical history, to mention, that Mr Perkins is not our countryman; but the age of jealousy against America has happily gone past, and we hail, with sincere pleasure, any circumstance which contributes to the scientific renown of our great descendants, and companions in freedom and intelligence.

† Professor Silliman has been so good as to forward to us an account of these very curious and highly important experiments, so early as to reach us before the arrival of the Number (Vol. VI. No. 2.) of the valuable Journal in which they will appear. We would have published the full account of this inquiry, but the printing of this Number was too far advanced to admit of this. We trust that the following abstract will convey a complete idea of the results.

inch or more in diameter, which appeared to be owing to the iron, remaining from the combustion of the carbon of that part of the piece, and which, being now oxidized to a maximum, assumed the usual colour of the peroxide of that metal.

"In various trials, the globules were formed very abundantly on the edge of the focus, and, in several instances, were studded around so thickly, as to resemble a string of beads, of which the largest were of the size of the smallest shot; others were merely visible to the naked eye, and others still were microscopic. No globule ever appeared on the point of the plumbago which had been in the focus of heat, but this point presented a hemispherical excavation, and the plumbago there had the appearance of black scoriæ or volcanic cinders. These were the general appearances at the copper pole occupied by the plumbago.

"On the zinc pole, occupied by the prepared charcoal, there were very peculiar results. This pole was, in every instance, elongated towards the copper pole, and the black matter accumulated there presented every appearance of fusion, not into globules, but into a fibrous and striated form, like the half-flowing slag found on the upper currents of lava. It was evidently transferred, in the state of vapour, from the plumbago of the other pole, and had been formed by the carbon taken from the hemispherical cavity. It was so different from the melted charcoal, described in my former communications, that its origin from the plumbago could admit of no reasonable doubt. I am now to state other appearances, which have excited in my mind a very deep interest. On the end of the prepared charcoal, and occupying frequently an area of a quarter of an inch or more in diameter, were found numerous globules of perfectly melted matter, entirely spherical in their form, having a high vitreous lustre, and a great degree of beauty. Some of them, and generally they were those most remote from the focus, were of a jet black, like the most perfect obsidian; others were brown, yellow, and topaz coloured; others still were greyish-white, like pearlstones, with the translucence and lustre of porcelain: and *others still limpid like flint-glass, or, in some cases, like hyalite or precious opal*, but without the iridescence of the latter. Few of the globules upon the zinc pole were perfectly black, while very few of those on the copper pole were otherwise. In one instance, when I used some of the very pure English plumbago (believed to be from Borrowdale), white and transparent globules were formed on the copper side.

"I detached some of the globules, and partly bedding them in a handle of wood, tried their hardness and firmness; they bore strong pressure without breaking, and easily scratched, not only flint-glass, but window-glass, and even the hard green variety, which forms the aquafortis bottles."

Having refitted the deflagrator with new zinc coils, so as to make it act with great energy, Professor Silliman obtained the following results, by using plumbago upon *both* poles. The parallelopipeds were one-fifth of an inch in diameter, and about 1 or 2 inches long; and, when brought into contact, they trans-

mitted the fluid with a splendour even more intense than when charcoal was used.

"On examining the pieces, I found them beautifully studded with numerous globules of melted plumbago. They extended from within a quarter of an inch of the point, to the distance of one-fourth or one-third of an inch all around. They were larger than before, and perfectly visible to the naked eye: They exhibited all the colours before described, from perfect black to pure white, including brown, amber, and topaz colours: Among the white globules, some were perfectly limpid, and *could not be distinguished by the eye from portions of diamond.*"

While again repeating the experiments, Professor Silliman obtained still finer results.

"The spheres of melted plumbago were in some instances so thickly arranged as to resemble shot lying side by side; in one case they completely covered the plumbago, in the part contiguous to the point on the zinc side, *and were, without exception, white, like minute, delicate concretions of mammillary chalcedony.* Among a great number there was not one of a dark colour, except that, when detached by the knife, they exhibited slight shades of brown at the place where they were united with the general mass of plumbago. They appeared to me to be formed by the condensation of a white vapour, which, in all the experiments where an active power was employed, I had observed to be exhaled between the poles, and partly to pass from the copper to the zinc pole, and partly to rise vertically in an abundant fume like that of the oxide proceeding from the combustion of various metals. It seems possible that it is white volatilized carbon, giving origin, by its condensation, in a state of greater or less purity, to the grey, white, and perhaps to the limpid globules*.

"I have already stated, that the white fume mentioned above, appears when points of charcoal are used. I have found that this matter collects in considerable quantities a little out of the focus of heat around the zinc pole, and occasionally exhibits the appearance of a frit of white enamel, or looks a little like pumice stone, only it has the whiteness of porcelain, graduating, however, into light grey, and other shades, as it recedes from the intense heat. In a few instances, I obtained upon the charcoal, when this substance terminated *both* poles, distinct, limpid spheres, and at other times they adhered to the frit like beads on a string. Had we not been encouraged by the remarkable facts already stated, it would appear very extravagant to ask whether this white frit and these limpid spheres could arise from carbon, volatilized in a white state even from charcoal itself, and condensed in a form analogous to the diamond. The rigorous and obvious experiments necessary to determine this question, it is not now practicable for me to make; and I must, in the mean time, admit the

* Upon exposing these globules to the solar focus, in a small jar of pure oxygen, Professor Silliman found, that they gave out part of their substance, viz. carbonic acid, to the oxygen.

possibility that alkaline and earthy impurities may have contributed to the result."

The next experiments of Professor Silliman were made upon anthracite and the diamond, by means of the oxy-hydrogen blowpipe of Dr Hare.

"My first trials were made, by placing small *diamonds* in a cavity in charcoal, but the support was, in every instance, so rapidly consumed, that the diamonds were speedily displaced by the current of gas. I next made a chink in a piece of solid quicklime, and crowded the diamond into it: This proved a very good support, but the effulgence of light was so dazzling, that although, through green glasses, I could steadily inspect the focus, it was impossible to distinguish the diamond, in the perfect solar brightness. This mode of conducting the experiment proved, however, perfectly manageable, and a large dish, placed beneath, secured the diamonds from being lost (an accident which I had more than once met with) when suddenly displaced by the current of gas. As, however, the support was not combustible, it remained permanent, except that it was melted in the whole region of the flame, and covered with a perfect white enamel of vitreous lime. The experiments were frequently suspended, to examine the effect on the diamonds. They were found to be rapidly consumed, wasting so fast, that it was necessary, in order to examine them, to remove them from the heat at very short intervals. They exhibited, however, marks of *incipient fusion*. My experiments were performed upon small wrought diamonds, on which there were numerous polished facets, presenting extremely sharp and well-defined solid edges and angles. These edges and angles were always rounded and generally obliterated. The whole surface of the diamond lost its continuity, and its lustre was much impaired; it exhibited innumerable very minute indentations, and intermediate and corresponding salient points; the whole presenting the appearance of having been superficially softened, and indented by the current of gas, or perhaps of having had its surface unequally removed, by the combustion. In various places, near the edges, the diamond was consumed, with deep indentations. These results seem to indicate that, were the diamond a good conductor, it would be melted by the deflagrator; and, were it incombustible, a globule would be obtained by the compound blowpipe."

Professor Silliman next subjected the *Anthracite* of Wilkesbarre, Pennsylvania, to similar trials.

"It was consumed," says he, "with almost as much rapidity as the diamond; but exhibited, during the action of the heat, an evident appearance of being superficially softened. I could also distinctly see, in the midst of the intense glare of light, very minute globules forming upon the surface. These, when examined by a magnifier, proved to be perfectly white and limpid, and the whole surface of the anthracite exhibited, like the diamond, only with more distinctness, cavities and projections united by flowing lines, and covered with a black varnish, exactly like some of the volcanic slags and semi-vitrifications."

"The anthracite of Rhode-Island is thought to be very pure. Dr William Meade estimates its proportion of carbon at 94 per cent. This anthracite I have just succeeded in melting by the compound blowpipe. It gives large brilliant black globules, not attractible by the magnet, but in other respects not to be distinguished from the dark globules of melted plumbago."

"I next subjected a parallelopiped of plumbago to the compound flame. It was consumed with considerable rapidity, but presented, at the same time, numerous globules of melted matter, clearly distinguishable by the naked eye; and when the piece was afterwards examined, with a good glass, it was found richly adorned with numerous perfectly white and transparent spheres, connected also by white lines of the same matter, covering the greater part of the surface, for the space of half an inch at and round the point, and presenting a beautiful contrast with the plumbago beneath, like that of a white enamel upon a black ground."

"In subsequent trials, upon pieces from various localities, foreign and domestic (confined however to very pure specimens), I obtained still more decided results; the white transparent globules became very numerous and as large as small shot; they scratched window glass—were tasteless—harsh when crushed between the teeth, and they were not magnetic. They very much resembled melted silex, and might be supposed to be derived from impurities in the plumbago, had not their appearance been uniform in the different varieties of that substance, whose analysis has never, I believe, presented any *combined* silex; and neither good magnifiers, nor friction of the powder between the fingers, could discover the slightest trace of any foreign substance in these specimens. Add to this, in different experiments, I obtained very numerous perfectly black globules, on the same pieces which afforded the white ones. In one instance they covered an inch in length, all around; many of them were as large as common shot: and they had all the lustre and brilliancy of the most perfect black enamel. Among them were observed, here and there, globules of the lighter coloured varieties. In one instance the entire end of the parallelopiped of plumbago was occupied by a single black globule. The dark ones were uniformly attracted by the magnet, and I think were rather more sensible to it than the plumbago which had been ignited, but not melted."

Professor Silliman, in a subsequent trial, found, that Kilkenny coal gave only white and transparent globules; an effect not likely to be produced by impurities, as this anthracite is said to contain 97 per cent. of carbon. In another experiment, Professor Silliman melted a piece of plumbago into two or three large limpid globules, and *nothing remained of the original appearance of the plumbago, but a small number of black points.*

ART. XXI.—*Celestial Phenomena, from July 1. to October 1. 1823, calculated for the Meridian of Edinburgh, Mean Time.* By Mr GEORGE INNES, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension*, instead of *Longitude* as formerly.

JULY.

D	H	′	″	
1.	13	21	36	☾ Last Quarter.
4.	14	33	48	☌ ☽ ♄
5.	2	19	38	☌ ☽ η ♉
6.	13	40	54	☌ ☽ ♂
	22	30	44	☌ ☽ ♃
	22	41	16	☌ ☽ 132 ♉
7.	3	25	13	☌ ☽ ☿
8.	6	23	6	● New Moon.
				☉ * eclipsed vis.
11.	0	27	11	☌ ☽ π ♌
	10	53	49	☌ ☽ ♀
12.	21	43	17	☌ ☽ ν ♌
15.	1	14	49	☽ First Quarter.
16.				☿ greatest elong.
18.	3	37	27	☌ ☽ π ♏
	3	47	16	☌ ♂ ♃
19.	2	53	3	Im. I. sat. ♃
20.	23	6	31	☌ ☽ λ ♐
21.	9	29	41	☌ ☽ ♅
	21	38	25	☌ ☽ ψ ♐
23.	3	22	25	○ Full Moon.
23.				☽ ecl. partly vis. †
	17	50	15	☉ enters ♌
30.	23	43	2	☾ Last Quarter.

AUGUST.

D	H	′	″	
1.	2	25	50	☌ ☽ ♄
				☿ greatest elong.
3.	17	55	47	☌ ☽ ♃
4.	6	41	31	☌ ☽ ♂
6.	2	48	22	☌ ☽ ☿
	3	57	54	☌ ☽ δ ♋
	13	46	9	● New Moon.
7.	3	13	50	Im. II. sat. ♃
9.	22	11	48	☌ ☽ ♀
11.	3	3	29	Im. I. sat. ♃
13.	14	12	23	☽ First Quarter.
14.	20	23	0	☌ ☽ σ ♏
	23	3	41	☌ ☽ α ♏
15.	20	51	36	☌ ☽ A Oph.
	23	47	27	☌ ☽ θ Oph.
17.	14	14	55	☌ ☽ ♅
21.	18	31	6	○ Full Moon.
22.	0	38	26	☌ ☽ θ ♒
24.	0	4	13	☉ enters ♍
27.	1	19	45	Im. I. sat. ♃
28.	10	30	14	☌ ☽ ♄
29.	6	5	43	☾ Last Quarter.
31.	9	57	44	☌ ☽ ♃

SEPTEMBER.

D	H	′	″	
1.	3	1	30	☌ ☽ δ ♊
	21	42	17	☌ ☽ ♂
3.	3	13	22	Im. I. sat. ♃
4.	22	5	25	☾ New Moon.
6.	10	38	23	☌ ☽ ☿
7.	19	4	52	☌ ☽ ♀
8.	2	52	31	Im. II. sat. ♃
11.	4	3	44	☌ ☽ σ ♏
12.	6	29	5	☽ First Quarter.
13.	0	19	41	Em. III. sat. ♃
14.	1	22	13	☌ ☽ 1 γ ♐
19.	1	28	40	Im. I. sat. ♃
	20	21	0	☌ ☿ α ♍
20.	1	26	23	Im. III. sat. ♃
20.	4	18	56	Em. III. sat. ♃
	8	41	36	○ Full Moon.
22.	12	20	0	☌ ☿ ♀
23.	20	45	50	☉ enters ♎
24.	15	29	41	☌ ☽ ♄
	22	27	57	☌ ☽ η ♉
25.				☿ greatest elong.
26.	3	22	4	Im. I. sat. ♃
	21	57	30	☌ ☽ 132 ♉
27.	12	34	36	☾ Last Quarter.
	18	56	16	☌ ☽ ε ♊
	23	34	55	☌ ☽ ♃
29.	21	40	31	☌ ☽ δ ♋
30.	10	35	27	☌ ☽ ♂

* The Elements of this Eclipse are given at great length in Vol. VIII. p. 174. of this *Journal*.

† See Vol. VIII. p. 177.

Art. XXII.—*Proceedings of the Royal Society of Edinburgh.* (Continued from Vol. VIII. p. 386.)

March 17.—At this Meeting, a paper was read by James Smith, Esq. of Jordanhill, giving an account of an undescribed Vitrified Fort, in the Burnt Isles of the Kyles of Bute.

At this meeting a paper by Dr Brewster was read, containing *Additional Observations establishing the existence of two New Fluids, possessing remarkable Physical properties, in the Cavities of Topaz, and other minerals.* An abstract of this paper is published in the present Number, p. 94.

A notice by Sir George S. Mackenzie, Bart. was read to the Society, respecting the Vertebra of a Whale, found in a bed of dark-bluish clay, near Dingwall, three miles from high-water mark. The height above the sea where this vertebra was found was 12 feet. The date of its deposition must have been very remote, as the great mass of gravel which the rivers of the country cut through, is a deposition subsequent to the clay which it covers, and in many places peat-mosses have been formed above the gravel. Sir George Mackenzie presented the vertebra to the Society's Museum.

April 7.—A paper, entitled, *Botanical Sketches of the Cleish Hills*, by George Walker Arnott, Esq. was read.

On the same evening, Dr Hibbert read a paper *On the Volcanic Origin of the appearances of Vitrification on Finhaven Hill in Angusshire.*

April 21.—A paper by Dr Brewster was read, *On the Properties of the two New Fluids found in Minerals, when taken out of the cavities; and on the existence of an insulated group of Crystals of Calcareous-spar in an Aqueous Cavity in Quartz.*

Specimens of the Fossil Bones found in the Hyæna Cave of Kirkdale, in Yorkshire, were presented to the Society by James Skene, Esq.

At the same Meeting, a notice respecting the White Copper of China, in a letter from John Barker, Esq. to Gilbert Laing Meason, Esq. was read. A specimen of the metal was presented by Mr Meason to the Society, for the purpose of analysis.

Captain J. D. Boswall, R. N. read a notice respecting the possibility of removing one of the Alexandrian Obelisks to England, which had been presented to Geo. IV. by Ali Pacha. Captain Boswall presented to the Society two Lithographic Drawings of both the Obelisks, the original plans and measurements of which were taken when he had the command of one of his Majesty's ships in the Mediterranean, in 1821.

May 5.—At this Meeting the following gentlemen were elected Ordinary Members of the Society.

Capt. Thomas David Stewart, of the Hon. East India Company's Service.	Andrew Fyfe, M. D.
	Robert Bell, Esq. Advocate.

The Rev. Dr Lee read a continuation of *Observations on the Life and Character of Sir George Mackenzie of Rosehaugh.*

Sir William Hamilton, Bart. read a paper *On the original Identity of the First and Second Aorists in the formation of the Greek Verb.*

May 19.—A paper by Dr Yule was read, *On certain Organic Remains, apparently Tropical; and on two varieties of Maize, which have ripened their Seeds in Mid-Lothian last summer, in the open air.*

June 2.—The following gentlemen were elected Ordinary Members of the Society.

Capt. Norwich Duff, R. N.	Liscombe John Curtis, Esq.
Warren Hastings Anderson, Esq.	Alexander Thomson, Esq.

At this Meeting Captain Basil Hall gave an account, illustrated by Drawings, of Mr Perkins's recent Discoveries and Inventions respecting the Steam-Engine.

June 17.—A paper was read, *On the Comparative Anatomy of the Human Eye, by Robert Knox, M. D.*

At the same Meeting was read an Account of some Electro-Magnetic Experiments made in the University of Utrecht. By Dr Van Beek, Major-General Baron Van Zuylen, Van Nyevelt, and Professor Moll. See this Number, p. 167.

Sir William Hamilton concluded his *Observations on the First and Second Aorists of the Greek Verb.*

A Description of Hopeite, a new Mineral, from Aix-la-Chapell, by Dr Brewster, was also read.

The Society adjourned its Meetings till Monday, the 3d of November.

Art. XXIII.—*Proceedings of the Wernerian Natural History Society.*—(Continued from Vol. VIII. p. 388.)

Feb. 8. 1823.—Dr Macdonald read a *Short Account of the Geognosy of part of the Point of Cantyre.* The Secretary read Dr Traill's *Account of the Guanaco of South America,* and his *Description of the Larus Scoresbii;* and also a Translation, by the Reverend Principal Baird, from the Chili Gazette, of a report by Senor Levasse, relative to Human Fossil Remains, discovered in South America. Professor Jameson communicated a short paper, by Mr Mathew Miller, *On the Increasing Temperature of the Earth as we descend in Mines.*

Feb. 22.—The Secretary read a paper by James Wilson, Esq. *On the different Opinions entertained regarding the Specific Distinction or the Identity of the Ringtail and Golden Eagles;* likewise a notice from Mr Selby, concerning some rare Birds which had occurred on the Coast of Northumberland, during the great storm, in the beginning of February of this year. Professor Jameson then read to the Society, a paper entitled *Speculations on the Modes of Formation of Opal, Hornstone and Diamond,* (printed in the present Number of our Journal, p. 163,—167.)

Mar. 8.—The Secretary read an account of a new Species of Pigeon from New Holland, by Sir William Jardine, Bart., illustrated by a drawing; likewise *Remarks on the Sertularia Cuscuta of Ellis,* by Dr Fleming; and a Notice by Mr L. Edmondston, in regard to the Ivory Gull and Iceland Gull. Professor Jameson communicated to the Society a *Register of the Thermometer, Adie's Sympiesometer, and Leslie's Hygrometer, kept at Corfu,* by Mathew Miller, Esq. of the 56th Regiment, with Remarks; likewise a letter from Mr William Jameson, dated Lima, descriptive of his Voyage round Cape Horn, and a Chart of the Course, laid down in the mode recommended by Captain Basil Hall.

Mar. 20.—Dr Yule read his *Observations on the presumed Analogy of certain Organs of the Embryo, in the several distinct Races of Vascular Plants.* The Secretary read a paper by James Wilson, Esq. *On the Genus Mergus.* Professor Jameson read Extracts of a Letter from Dr Oudney, leader of

the African Expedition, dated Mourzuk, 17th September 1822; likewise the first part of Mr Macgillivray's *Remarks on the Specific Characters of Birds.*

April 5.—The Secretary read an Extract from a Letter relative to the appearance of Pompeii, written by Lieutenant Boyd, R. N., and communicated by Mr Arnott; also a *Description of a reversed Species of Fusus*, by Dr Fleming. Mr Greville then read *Observations on the Formation of Lead-Spars*, communicated by Mr Braid of Leadhills. And Mr Deuchar exhibited and explained some curious Experiments on Crystallization.

April 19.—The Secretary read a paper by Dr Knox *On the Anatomy of the Beaver*; and Observations by Mr Don, on a new Natural Family of Plants, to be called *Cobeaceæ*. Dr Knox then read an *Inquiry into the Original and Characteristic Differences of the Native Races inhabiting the extra-tropical part of Southern Africa.* Professor Jameson gave an account of a communication from Dr Boué, dated Vienna, in which he controverts the late Observations of Professor Buckland of Oxford, in regard to the Secondary Formations of the Alps of Switzerland, and also detailed his Observations on the Pyrenees, and South of Germany.

April 26.—Mr Arnott read a paper, by Mr L. Edmondston, *On the Black-billed Auk and Lesser Guillemot*, and Professor Jameson described the specimens exhibited. Dr Knox read a paper *On some Peculiarities of the Structure of the New Holland Casowary.* A memoir on the *Bignoniaceæ*, by Mr Don, was read; and likewise the first part of Mr Ellis's *Account of Dr Rusconi's Observations on the Natural History and Structure of the Aquatic Salamander.* Before the close of the Meeting, Professor Jameson gave an account of a series of Models, exhibited at the Meeting, representing the different Indian Castes in Bengal; also of some Cinerary Urns, lately dug up at Dean Bank, near Stockbridge. Some remarkable Javanese Deities, and a complete set of Musical Instruments from Nepaul, were likewise exhibited.

ART. XXIV.—*Proceedings of the Society of Arts for Scotland.*

THE Society for the promotion of the mechanical and useful arts in Scotland, was first announced in this Journal in December 1819, as on the eve of being instituted, "for rewarding inventions of public utility, and for disseminating useful knowledge among the industrious classes of society *."

This institution has for some time been regularly organised, and already consists of more than 200 members. At a general meeting of the Society, held on the 18th November 1822, Sir William Arbuthnot, Bart. Lord Provost, in the chair, the following Committees were appointed for carrying on the business of the Society.

Committee on Accounts.

Sir William Arbuthnot, Bart.	Gilbert Innes, Esq.
Henry Jardine, Esq.	George Forbes, Esq. Treasurer, *ex officio.*
Thomas Allan, Esq.	

Committee on Laws and Regulations.

Reverend Dr Macknight.	James Skene, Esq.
Reverend Dr Brunton.	

Committee on the Chemical Arts.

Dr Hope.	Dr Fyfe.
Alexander Irving, Esq	Thomas Sivright, Esq.

Committee on the Mechanical Arts.

Professor Wallace.	Mr Whitelaw.	
James Jardine, Esq.	Dr Brewster, Director,	*ex officio*
Robert Stevenson, Esq.	John Robison, Esq. } Secretaries,	*ex officio*
Andrew Waddell, Esq.	T. G. Wright, Esq. } Secretaries,	*ex officio*
Mr James Milne.		

At this meeting the following gentlemen, not resident in Scotland, were elected honorary members of the Society.

James Watt, Esq. Soho.	Major Colby, F. R. S.
Peter Ewart, Esq. Manchester.	Edward Troughton, Esq. F. R. S.
John Rennie, Esq. F. R. S.	John Barton, Esq. London.
J. F. W. Herschel, Esq. F. R. S.	M. Reichenbach, Munich.
Charles Babbage, Esq. F. R. S.	M. Frauenhoffer, Munich.
Rev. Dr Brinkley, Dublin, F. R. S.	Professor Christian, Paris.
Arthur Aikin, Esq. S. S. A. London.	M. Le Chevalier Dupin, Paris, F. R. S. E.
Davies Gilbert, Esq. M. P. F. R. S.	M. Bettancourt, Petersburg.
—— Murdoch, Esq. Soho.	M. Schumacher, Copenhagen, F. R. S. E.
John Farey jun. Esq. C. E.	M. Berzelius, Stockholm, F. R. S. E.
Jacob Perkins, Esq. London.	M. Ermann, Berlin.

* See Vol. II. p. 193.

27th Dec. 1822.—*Mechanical Arts.*—At this meeting the following communications were made to the Committee.

1. A new method of raising the hulls of sunken vessels; by Mr David Masterton, Glasgow.
2. A model of a new method of applying the power of steam to impel boats; by Mr R. Whytock, Edinburgh.
3. A model of a new construction of wheels for carriages, called a Moveable Railway; by Mr Heriot, Duddingston.
4. A new instrument called an Eidograph, for copying, reducing, and enlarging drawings; by Professor Wallace.
5. A method of forming epicycloidal teeth on watch and clock wheels; by Mr Lecount, R. N.
6. A method of softening and dispersing the light of ground glass-shades for lamps, so as to prevent any injury to the eyes of those who use them; by Dr Brewster, Edinburgh.
7. A method of constructing large lenses for light-houses or for burning glasses; by Dr Brewster.
8. An improved percussion lock; by Mr Forrest, Jedburgh.
9. A model of a new method of propelling boats; by Dr Ranken of the Honourable East India Company's Service.
10. An improved Saccharometer; by Mr Peter Hill, optician, Edinburgh.
11. An Apograph, for copying, reducing, and enlarging drawings; by Mr Andrew Smith of Mauchline, Ayrshire.
12. A new universal standard wire-guage; by John Robison, Esq.

These different inventions were examined and reported upon by the two Committees, at meetings held on the 21st December 1822, on the 7th and on the 14th January 1823.

17th March.—At a general meeting of the Society held this day, Alexander Irving, Esq. in the chair, the Secretary read a report on the state and prospects of the Society. Various models of useful inventions were laid before this meeting, besides those which were regularly submitted to the Society. The following were among the most important.

1. A steam and sailing vessel of an improved construction; by Andrew Waddel, Esq. Hermitage Hill, Leith.
2. Steam-boat paddles; by Mr John Milne, teacher of architectural drawing.

3. A new Press for goods; by Mr John Ruthven, Edinburgh.
4. An elevating screw quoin, for pointing heavy guns; invented by Andrew Waddel, Esq.
5. Model of a Chinese mangle; communicated by Andrew Waddel, Esq.
6. A Chinese boat for shrimp-catching; communicated by Andrew Waddel, Esq.
7. A new mode of striking house-bells without wires or cranks; proposed by the late Professor Robison, and executed by Mr James Milne.
8. An apparatus for raising a block and tackle to be fastened to the window of a house on fire; invented by Mr A. Melrose.
9. Two new Achromatic telescopes, constructed by M. Frauenhoffer of Munich.

12th April.—At a meeting of the Council held this day, a list of premiums was prepared for the year 1823–24. This list, containing twenty-two subjects, has been extensively circulated, and will be found at the end of this Journal. The following are a few of the general subjects for premiums.

In the Mechanical Department.

1. For the most important discovery in mechanics, during the season 1823–1824—*The Keith gold medal.*
2. For the best set of experiments on any branch of practical mechanics—*The Keith silver medal.*
3. For the best set of experiments on the apparatus called "Barker's Mill," the tube of the model not to be less than 4 feet high and 4 inches diameter—*An honorary medal.*
4. For the most important communication of useful inventions or practices from foreign countries, not yet known or adopted in Britain—*An honorary medal.*
5. For the most important mechanical invention, applicable to agriculture or manufactures—*An honorary medal.*
6. For the most economical mode of forming diagrams to illustrate books of science, to be printed along with the text or separately—*An honorary medal.*
7. For any important improvement in the construction of balance, or of pendulum time-keepers, *by artists residing in Scotland*—*An honorary medal.*

In the Chemical Department.

8. For the most important discovery in the chemical arts, during the season 1823-24—*An honorary medal.*
9. For the best set of experiments on the treatment of foreign wines, with a view to produce early maturity and improved quality—*An honorary medal.*

In the General Department.

10. For the best and cheapest apparatus for producing oil gas on a scale sufficiently small for common dwelling-houses; the account to specify the average quantity of gas produced from a gallon of oil of a certain price—*An honorary medal.*
11. For the best specimen of lithographic printing produced by printers resident in Scotland—*A gold medal of £20, or a medal of £10 and £10 in money.*
12. For the second best ditto—*A medal of £5, and £7 in money.*
13. For the third ditto—*A medal of £3, and £5 in money.*

The papers of competitors (accompanied with sealed letters, containing their names and addresses) to be left with the Secretary before the end of March 1824.

A general exhibition of new and useful inventions will be made annually at the general meeting in May, when the prizes will be distributed.

As the effects of this national institution must depend, to a certain extent, on the amount of the funds which shall be placed at its disposal, we trust that the members of the Society will use their best exertions to promote its objects.

The prospectus of this Institution was laid before the Asiatic Society of Calcutta, on the 14th November 1822, by that eminent and patriotic individual Major-General Hardwicke, who drew up an address recommending it to the patriotism of our countrymen in the East; and we have the satisfaction of stating, that the following distinguished individuals stand at the head of the list of members in Bengal.

The Marquis of Hastings.	The Honourable W. B. Bayley.
The Marchioness of Hastings.	Major-General Hardwicke.
The Honourable J. Adam.	James Calder, Esq.

ART. XXV.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Comet of Encke re-discovered in New South Wales.*—On the 2d of June 1822, Mr Rumker re-discovered in Gemini the periodical comet of Encke, which has excited so much notice, and from which it appears, that the revolution of this comet in 1204 days is put beyond a doubt. This comet was observed in 1786, 1795, 1801, 1805, and 1818; and by a comparison of all these observations, he calculated two sets of elements, which represented the observations within two minutes of a degree. In these elements, the revolution for 1819 was 1203,452 days, and 1204,452, and half the greater axis 0.3472191 and 0.3474612. With these data, M. Encke computed ephemerides of the comet for 1822. He announced that he had little hopes of its being seen in Europe in 1822, as before June it would be extremely faint, and always near the horizon, and in the month of June it would set at the same time with the sun. He added, however, "*that in south latitude 34°, the comet, in the beginning of June, would be elevated 24° above the horizon at sunset, and would then be as bright as a star of the fourth magnitude.*" Our readers cannot fail to remark the singularity of the circumstance, that M. Rumker, who accompanied Sir Thomas Brisbane to New South Wales, should have discovered this comet on the 2d June 1822, at Paramatta, in 33° 48′ 45″ of South latitude.—See *Zach's Correspond. Astron.*, vol. viii. cah. 1., and *Bibl. Universelle*, Mars 1823, p. 179.

2. *Errors of the Lunar Tables from 1783 to 1821.*—The following are the results of the comparison of the different Lunar Tables with 4068 observations, as ordered by the Board of Longitude:

Mayer and Mason's Tables.	Mean Error. Long.	Lat.
From 1783—1788,	30″.4	14″.4
Mason's Tables.		
From 1789—1804,	27″.5	13″.6
Laplace and Mason.		
1805—1812, -	20″.5	8″.2
Laplace and Burg.		
1813, -	± 6″.5	8″.3
1814, -	± 5.1	7.7
1815, -	± 4.8	6.3
1816, -	± 5.6	6.5
1817, -	± 5.3	6.7
	— 0.5	
1818, -	± 6.4	6.7
	— 2.3	
1819, -	± 6.1	7.0
	— .2	

Laplace and Burg.	Mean Error. Long.	Lat.
1820, -	± 5″.3	7″.6
	— 1.7	-
Laplace and Burckhardt.		
1817, -	± 4″.7	4″.7
	+ 3.1	
1818, -	± 5.0	5.2
	+ 2.3	
1819, -	± 4.5	
	+ 3.0	4.6
1820, -	± 4.4	5.7
	+ 3.4	
1821, -	± 4.4	4.3
	— 3.0	

See *Quarterly Journal*, vol. x. p. 166. and vol. xv. p. 131.

OPTICS.

3. *Phosphorescence and Structure of the Chara vulgaris and hispida.*—While examining the distribution of the aggregated groups of the carbonate of lime which forms a great portion of these plants, and which are essential and integral parts of their constitution, Dr Brewster found that the plants were phosphorescent, when laid upon heated iron, so as to display their entire outlines in the dark. He ascertained that each group or mass of the calcareous matter consisted of minute aggregated particles, which possessed double refraction, and had regular neutral and depolarizing axes. They are held to the stem of the plant by a very fine transparent membrane. It is surprising that some of our most eminent botanists should have been so much misled as to suppose the calcareous matter to be an accidental deposit, from the water in which they vegetate.

METEOROLOGY.

4. *Remarkable Hail-shower.*—In August 1813, the British army occupied a range of mountain district, extending from Roncesvalles to St Sebastian. About this period, the forces under Marshal Soult were anxious to get possession of the pass of

Maya, situated at the top of the Pyrenees, and one of the few roads on the western ridge, by which cavalry or artillery can enter Spain. A division of British infantry were ordered to take possession of the pass, and remain there till 2 o'clock; the day was very warm, and the sky clear and cloudless. About 3 o'clock, the summits of the adjoining hills were enveloped in a cloud of pitchy darkness, leaving but an obscure light as it quickly passed over our heads, and producing a peculiar noise among the rocks. As the troops began to descend the mountain, they were overtaken by a violent hail-shower, which lasted about twenty minutes, and created more alarm among its victims than the approaching contest. Contrary to my expectations, the storm was unaccompanied with either thunder or lightning, while the stones increased from the size of a bean to that of a hen-egg. These were transparent masses of ice, round in form, and having on their surface icicles about the length and thickness of the prong of a common silver fork. From this circumstance, I am induced to believe, that the hail had been twice as large in the higher regions of the atmosphere, and before they reached the surface of the earth, as the stones themselves, and the spiculæ or icicles on their surface, had all the appearance of being partially melted down by heat. Fortunately the troops had their backs to the storm, else many of them must have lost their eyes, and been otherwise maimed, from the weight of the stones, and the force with which they fell. I have heard some of the men say, "their thin tin-kettles were *dinged* (or dimpled), by the shower;" and I am inclined to believe so, from the circumstance of my being rendered lame for twenty-four hours, by one of them falling on my toe. The rattling of these stones on the canteens and kettles of the men, and their gradually increasing in size for some time, rendered the scene truly alarming, even to those who had been in the daily habit of exposing their lives to the dangers of war. I am not aware of the extent of this shower, nor have I been able to ascertain its injurious consequences, from the French or Basque Journals; but from the damage done to the orchards and grain at the bottom of the Pyrenees, I should suppose it to have occupied a range of three miles, proceeding from Roncesvalles into the valley of Bastan.

R. S. Stewart, Esq. *Belfast.*

5. *Severe Cold of last winter in Holland.*—We are informed by Professor Moll, that the severe cold which we recorded in our last Number, (vol. viii. p. 396. &c.), as observed at the Doune in Inverness-shire, took place also in Holland; but it was not so intense, owing to the greater elevation of the Doune above the sea. At Utrecht, the thermometer descended so low as —11°, which was lower than had ever before been observed. We expect to be able to lay before our readers in next Number, a full account of this remarkable condition of the temperature in Holland.

6. *Variations in the Bulbs of Thermometers.*—We are informed by an eminent correspondent Professor Moll, that there is considerable reason to doubt the facts observed by Flauguergues and Bellani, as given in our last Number, (vol. viii. p. 397.) Professor Moll has examined several very old Thermometers, made by Prius, an apprentice of Fahrenheit, which are considered the best of the old ones, and compared them with new ones of great accurracy made by Dollond and Newman; but he could discover no material difference.

7. *Meteoric Stone of Epinal.*—This meteorite, mentioned in our last Number, has been analysed by Vauquelin. It was covered with a fused black coating. Within this it had a grey colour, and exhibited many metallic points. When ground, a great number of particles of metallic iron were separated. A quantity of 4 grammes or 61.8 grains gave,

Silica, - - -	1.40
Oxide of Iron, - -	2.51
Sulphur, - - -	0.09
Oxide of Chrome, - -	0.01
Oxide of Nickel, - -	0.02
Magnesia, - - -	0.17
Lime and Potash, - -	0.50
	4.70

Ann. Chim. xxi. 325.

ELECTRICITY.

8. *Animal Electricity.*—Mr Glover has published the following method of receiving the electrical shock from a cat. Place the left hand under the throat, with the middle finger, and the thumb slightly pressing the bones of the animals shoulder,

then gently passing the right hand along the back, sensible electrical shocks will be felt in the left-hand.—*Phil. Mag.* (vol. x. p. 46).

MECHANICS.

9. *Mr Babbage's Calculating Engine.*—It gives us great pleasure to be able to state, that there is every probability of Mr Babbage being enabled, by pecuniary aid from Parliament, to construct his machinery for calculating and printing mathematical tables. A Committee of the most distinguished Members of the Royal Society of London, have transmitted the following report (dated May 1. 1823), to the Lords Commissioners of his Majesty's Treasury, and we earnestly hope, that no narrow views of economy will disappoint the just expectations of the scientific world:

"That it appears to the Committee, that Mr Babbage has displayed great talents and ingenuity, in the construction of his machine for computation, which the Committee think fully adequate to the attainment of the objects proposed by the inventor; and that they consider Mr Babbage as highly deserving of public encouragement in the prosecution of his arduous undertaking."

10. *Tenacity of Iron-wire not altered by Heat.*—A set of experiments have been made by Colonel Dufour at Geneva, for the purpose of ascertaining if the tenacity of iron-wire was altered by different degrees of temperature, between several degrees below the freezing point, and the heat of boiling water. The wire which he used was 0.85 of a millimetre in diameter, or No. 4. of commerce, the absolute force of which was between 46 and 48 kilogrammes. Having made it pass through a frigorific mixture of—$22\frac{1}{2}°$ centigrade, he found that it broke, where it was not cold, with 47 kilogrammes in two experiments, and with 46 in another. He then made the same experiment in a temperature of $92\frac{1}{2}°$ cent. The wire broke in the first experiment beyond the heated part, with $45\frac{1}{2}$ kilogrammes; and in the 2d experiment within the heated part with $46\frac{1}{2}$ kilogrammes. He next heated one part of the wire to $92\frac{1}{2}°$ cent., and cooled another with the frigorific mixture. The wire now broke between the heated and cooled part with $45\frac{1}{2}$ kilogrammes. Hence it follows that the tenacity is not affected within these limits of temperature.—*Bibl. Univers.* Mars 1823, p. 220.

II. CHEMISTRY.

11. *Condensation of Gases into Liquids.*—Mr Faraday has announced the important discovery, that various gases may be condensed into liquids. He succeeded first with *chlorine*, by the following method: A portion of the solid and dried hydrate was hermetically sealed in a small bent tube of glass. It was then heated to about 100° of Fahrenheit, and a yellow vapour was formed, which condensed into a deep yellow liquid, heavier than water (specific gravity about 1.3). By relieving the pressure, by breaking the tube, the condensed chlorine instantly assumed its gaseous form. By condensing perfectly dry chlorine into a tube by a syringe, a portion of it becomes liquid under 4 or 5 atmospheres. Mr Faraday next put some *muriate of ammonia* and *sulphuric acid* into the opposite ends of a bent glass-tube, and sealing it hermetically, and allowing the acid to run upon the salt, *muriatic acid* was generated under such a pressure, that it assumed the liquid form. It has an orange colour, and is lighter than sulphuric acid, and whenever the pressure is removed, it assumes the gaseous form. By pursuing this method, *sulphuretted hydrogen*, *sulphuric acid*, *carbonic acid*, *cyanogen*, *euchlorine*, and *nitrous oxide*, have been converted into limpid fluids. *Quart. Journ.* xv. 74. 163.

12. *Hydrate of Chlorine.*—In order to obtain good crystals of hydrate of chlorine, Mr Faraday introduces into a clean bottle of the gas a little water, but not so much as to convert the whole into hydrate. The bottle is then placed for a few days in a temperature at or below freezing, and the hydrate is produced in a crust, or in dendritical crystals, which, when left to themselves for a few days, sublime, like camphor, from one part of the bottle to another, and form brilliant, and comparatively large crystals, of a bright yellow colour, and which seem to be acute flattened octohedrons, with the three axes of different dimensions. Their specific gravity seemed to exceed 1.2. Mr Faraday found that these crystals consisted of

Chlorine,	26.3
Water,	73.6

a result which is the mean of several experiments. *Quart. Journ.* xv. 72.

13. *Maximum density of Water.*—Our readers are already acquainted with the very ingenious method by which Dr Hope determined the maximum density of water to be between 39½° and 40° of Fahrenheit. (See *Edin. Transactions*, vol. v. p. 379.). Professor Moll of Utrecht has been very recently occupied with the same inquiry, in which he employed the very same method as Dr Hope. The result of his observations is, that the point of maximum density lies between 39° and 40°, which shews the great accuracy of Dr Hope's determination. *Letter from Professor Moll.*

14. *On the Effect of Heat and Pressure on certain Fluids.*—From a number of curious experiments on this subject by M. le Baron Cagnard de la Tour, he draws the following conclusions: 1. That *alcohol, naphtha*, and *sulphuric ether*, submitted to heat and pressure, are converted into vapour in a space *a little more than double* that of each liquid. 2. That an increase of pressure, occasioned by the presence of air, presented no obstacle to the evaporation of the liquid in the same space, but only rendered its dilatation more regular. 3. That water, though susceptible of being reduced into very compressed vapour, has not yet been submitted to perfect experiments, on account of the imperfect closing of the digester at high temperatures, and also on account of its action on tubes of glass. Baron de la Tour afterwards found, that when *ether* was converted into vapour, in a space less than *twice* its original volume, which happened at a temperature of 320° of Fahrenheit, it exerted a pressure of between 37 and 38 atmospheres. When *alcohol* was reduced into vapour in a space rather less than *thrice* its original volume, which happened at a temperature of 405°, it exerted a pressure of 119 atmospheres. Our author also determined, that at a temperature near that of melting zinc (about 700° of Fahrenheit) *water* may be converted into vapour in a space nearly *four* times that of its original volume.

15. *Mr Phillips' Analysis of Uranite.*—According to M. Berzelius, "uranite is a compound oxide of uranium with lime and "water, or a true salt with a base of lime, in which the oxide "acts as an acid." Mr R. Phillips has, however, found it to

be a true phosphate. A specimen from Cornwall gives

Silica,	0.5	or neglecting Silica,	Phosphate of Uranium,	73.2
Phosphoric Acid,	16.0		Phosphate of Copper,	12.3
Oxide of Uranium,	60.0		Water,	14.5
Oxide of Copper,	9.0			
Water,	14.5			

Ann. Phil. v. 59.

16. *Analysis of Inverleithen Waters.*—The analysis of Inverleithen waters, as made by Dr Fyfe, gives:

Carbonate of Magnesia,	10.23 Grains.
Muriate of Lime,	19.02
Muriate of Soda,	31.39

This is the produce of an English pint (wine measure), of the strongest spring. There is another which gives:

Carbonate of Magnesia,	5.3 Grains.
Muriate of Lime,	9.5
Muriate of Soda,	21.2

III. NATURAL HISTORY.

MINERALOGY.

17. *Ripel and Pristanowsky's Works.*—Ripel, an intelligent mineralogist, is preparing a great work on the structure of the Alps, to be accompanied with numerous sections and maps. High expectations are formed of Pristanowsky's work on Tuscany, about to appear; as he, in opposition to all the French, and most of the German geologists, advocates the Neptunian view of their formation. The same active observer has lately published an interesting tract, in which he shews, that, in the newer rocks, along both sides of the Appennine range, there are extensive sulphur beds; that these are more considerable on the south than on the north side, and that probably the fuel of Italian volcanoes is sulphur.

18. *Geognosy of Brazil.*—From the account of Eschwege, it appears that this country is composed of rocks of the primitive, transition, secondary and alluvial classes. The primitive rocks he divides into two classes; under the first, he includes granite, syenite, trap, gneiss, mica-slate and limestone; under the second, clay-slate, quartz-rock and quartzy mica-slate, chlorite-slate, talc-slate, potstone, and slaty quartzose micaceous iron-

ore. No gold occurs in the first set of primitive rocks, and, with the exception of a great deposit of magnetic iron-ore in the province of Saint Paul, no other metalliferous minerals. A bed of quartz, with gold, occurs in the quartz-rock and quartzy mica-slate. This bed, which varies from an inch to six feet in thickness, is composed of quartz and schorl. Veins of quartz with gold also traverse this rock; and these, besides the gold, contain iron-pyrites, arsenical pyrites, and antimony. Some veins contain only kyanite. The slaty quartzose micaceous iron-ore contains gold, iron-pyrites, actynolite and kyanite; also beds of quartz with gold; beds of magnetic iron-ore, and of iron-glance; and also beds of brown iron-ore, chlorite-slate and talc-slate. The beautiful yellow Brazilian topazes, also beryl? occur in nests and small veins enveloped in lithomarge, in the chlorite and talc-slates subordinate to the clay-slate; also the rare euclase, and frequently large and beautiful crystals of iron-glance, with crystallized talc, rock-crystals with adhering topazes, topaz-crystals with included rock-crystals, and kyanite, encrease the interest of these repositories. Beautiful red-lead spar or chromate of lead occurs in the potstone, and beds of iron-glance, upwards of 1000 feet thick, occur in some places. The transition rocks are clay-slate, common flinty slate, greywacke, greywacke-slate, and compact limestone. The sandstone named *Quadersandstein*, often highly impregnated with iron, seems to be a predominating secondary rock. Hematitic brown iron-ore abounds in it, and it contains beautiful Wavellite. The Jura limestone, which occurs in abundance, contains fossil fishes, flint, echinites, and also rocks of the salt formation. The alluvial rocks in Brazil are of two descriptions: one kind occurs principally on ridges of mountains and upon their sides, the other in the bottoms of valleys. The alluvium of the first kind, named in the country *Tapanhoacanga*, is composed of fragments of iron-mica and magnetic iron-stone, connected together by means of red or brown iron-ochre. It is often very rich in gold, contains beds of brown iron-ore, and large nests of *Wavellite*. The alluvial substances of the second kind occur principally in valleys, and are of two principal varieties, the one, which is compact, is a *conglomerate* of pieces of quartz cemented together by means of brown and red iron-ore, and which sometimes contains gold, and

also *diamonds*; the other composed of sand, gravel and clay, and known under the name *Cascalho*, often affords much gold, and many *diamonds*.

19. *Matrix of the Brazilian Diamond.*—In Mr Heuland's splendid collection, there is a Brazilian diamond imbedded in brown iron-ore; another, also in brown iron-ore, in the possession of M. Schuch, Librarian to the Crown Princess of Portugal; and Eschwege has in his own cabinet a mass of brown iron-ore, in which there is a diamond in a drusy cavity of a green mineral, conjectured to be arseniate of iron. From these facts he infers, that the matrix, or original repository, of the diamond of Brazil, is brown iron-ore, which occurs in beds of slaty quartzose micaceous iron-ore, or in beds composed of iron-glance and magnetic iron-ore, named by him *Itabirite*, both of which are subordinate to what he considers as primitive clay-slate.

20. *Human Fossil remains.*—Count Razoumaski has lately found, associated with remains of elephants, skulls and other bones of a race of people, conjectured to be very different from those that now people the globe. They seem to have buried their dead in hillocks, and all the skulls examined had a most remarkably elongated form. Schlottheim, we understand, will publish an account of these remains.

IV. GENERAL SCIENCE.

21. *Memoirs of the Wernerian Natural History Society.*—The second part of the fourth volume of the Memoirs of the Wernerian Society is just published. The following are the titles of the papers contained in it:—Sketch of the Geognosy of part of the Coast of Northumberland, by W. C. Trevelyan, Esq.—On the Fossil Remains of Quadrupeds, &c. discovered in the Cavern at Kirkdale, in Yorkshire, by the Rev. George Young, Whitby.—List of Birds observed in the Zetland Islands, by L. Edmondstone, Esq.—An illustration of the Natural Family of Melastomaceæ, by Mr David Don.—Examination by Chemical Re-agents of a Liquid from the Crater of Vulcano, by Mr John Murray.—Notice of Marine Deposites on the margin of Loch Lomond, by Mr J. Adamson.—Descriptions of the Esculent Fungi of Great Britain, by R. K. Greville, Esq.—

Notice relative to the Habits of the Hyæna of Southern Africa, by Dr R. Knox.—An Account of Three large Loadstones, by Mr John Deuchar.—Recollections of a Journey from Kandy to Caltura, by the way of Adam's Peak, by Simon Sawers, Esq. and Mr Henry Marshall, Surgeon.—Some Observations on the Falco chrysaetos and F. fulvus of Authors, proving the identity of the two supposed species, by P. J. Selby, Esq.—Remarks on the different Opinions entertained regarding the specific Distinction, or Identity, of the Ring-tailed and Golden Eagles, by James Wilson, Esq.—On the Natural Expedients resorted to by Mark Yarwood, a Cheshire Boy, to supply the want which he has sustained from Birth, of his Fore-Arms and Hands, by Dr Hibbert.—Notice in regard to the Temperature of Mines, by Mathew Miller, Esq.—Remarks on some of the American Animals of the Genus Felis, particularly on the Jaguar, by Dr Traill.—Observations on some Species of the Genus Mergus, by James Wilson, Esq.—Observations on the Sertularia Cuscuta of Ellis, by the Rev. Dr Fleming.—Remarks on the Guanaco of South America, by Dr Traill.—On a Reversed Species of Fusus, by Dr Fleming.—Notice of a Specimen of the Larus eburneus, shot in Zetland; and further remarks on the Iceland Gull, by L. Edmondston, Esq.—Observations on the formation of the various Lead-Spars, by Mr James Braid, Surgeon.—Description of a New Species of Larus, by Dr Traill.—Remarks on the Specific Characters of Birds, by Mr W. Macgillivray.—Notes on the Geognosy of the Crif-Fell, Kirkbean, and the Needle's Eye in Galloway, by Professor Jameson.—Observations on the Anatomy of the Beaver, considered as an Aquatic Animal, by Dr Knox.—Speculations in regard to the Formation of Opal, Wood-stone, and Diamond, by Professor Jameson.—Map of Mackenzie's River, by Mr W. F. Wenzel.—Observations on some Species of the Genus Vermiculum of Montagu, by Dr Fleming.—Notes in regard to Marine Shells found in the Line of the Ardrossan Canal, by Captain Laskey.

22. *General Direction of Lightning.—Hail-Chart.*—It results from a series of observations made in Germany, and communicated to Kefferstein, that the general direction of lightning is from East to West, comparatively seldom from North to South. It appears from another series of observations in Germany, that

most of the lightning rises in the west and extends towards the east. Numerous observations have been made on the effects of lightning on trees of different kinds. Experienced foresters tell us that the oak is often struck, but the beech seldom, even in those cases where the trees are intermixed. The Natural History Society of Halle proposes to publish a *hail-chart* of Germany, with the view of shewing its extent, position, and magnitude during a series of years. It is also proposed to publish a series of maps representing the direction lightning takes in different parts of the world, particularly in Europe.

23. *Typhon of Chinese Sea.*—It is alleged by Tilesius, who accompanied Krusenstern, that the cause of the typhon of the Chinese sea is to be sought for in the bowels of the earth, and depends on agitations at the bottom of the sea.

24. *Carlsbad Springs.*—Berzelius finds in the water of the hot springs of Carlsbad, besides the substances mentioned by Klaproth, *fluate of lime*, *phosphate of lime*, *carbonate of Strontian*, and *oxide of manganese*.

25. *Arsberattelser om Vetenskapernas, Framsteg*, &c.—An annual Report of the progress of the Sciences for the year 1821, under this title, has been published by the Royal Academy of Sciences of Stockholm. It contains, 1. Short History of the Society, by its President, F. Wirsen. 2. History of the progress of discovery in Chemistry and Natural History, by Berzelius, of which we have received a translation. 3. Cronstrand on Astronomy. 4. Dalman on Zoology. 5. Wiekstrom on Botany.

26. *Tidsskrift fur Naturvidenskaberne*, 1822.—This periodical work is conducted by Professors Oersted, Hornemann, and Reinhardt, in conjunction with Dr Bresdorff. Six numbers appear annually. The first heft or number contains, 1. View of the progress of Chemistry, during the present century, by Professor Oërstedt. 2. Professor Schow on the Snow line. 3. Breddsdorf's Geognostical Observations, made during a journey in Jutland; this refers particularly to the chalk formation. 4. Schow on the unexpected appearance of different plants, and on equivoca generation. 5. Bredadorff on Torfmoorkohle.

6. Zeise's analysis of the Coal found in Iceland. 7. Letter from Probst Deinboll in Finmark, in regard to botany and physics.

27. *Euler's Letters to a German Princess on various subjects of Physics and Philosophy.*—A new edition of this work, which has been long out of print, is on the eve of being published in two volumes 12mo. Independently of the great popularity of this production of the celebrated Leonhard Euler, which has gone through many editions in different parts of Europe, it possesses a particular interest at the present time, in consequence of its containing a popular view of the doctrine, that light consists in the undulations of an ethereal medium, which is now generally adopted, in consequence of recent discoveries in optics. In this edition, which is edited by Dr Brewster, a popular life of the author, and various notes, have been added. The translation has undergone very essential improvements, and the plates have been re-engraved, and much improved.

28. *Method of preserving Preparations.*— Mr W. Cooke of London, has found, that all preparations of animal bodies may be preserved by a solution of muriate of soda or common salt. He finds that if used *a little below saturation*, it will preserve animal substances for an indefinite period, at all the temperatures of our atmosphere.—*Trans. of the Society of Arts*, vol. xxxvii. p. 43.

29. *Asiatic Society of Great Britain and Ireland.*—This very important institution, which was organised on the 15th March last, owes its origin to the activity and zeal of Henry Thomas Colebrooke, Esq. As this distinguished individual has been nominated Director of the institution, we look forward with the highest pleasure to the publication of its Transactions. The following are the office-bearers:

President, The Right Honourable Charles Williams Wynn.

Director, Henry Thomas Colebrooke, Esq. F. R. S. Lond. & Edin.

Vice-Presidents, Sir George Thomas Staunton, Bart.; Sir John Malcom, G. C. B.; Sir Alexander Johnston, Knight; Colonel Mark Wilks.

Treasurer, James Alexander, Esq.

Secretary, George Henry Noehden, LL. D.

30. *Volcano of Barren Islands.*—This volcano was visited by Captain Webster of the Juliana in March last. Having entered a small bay, with the view of landing, they were, at the distance

of 100 yards from the shore, assailed by hot puffs of wind, and, upon dipping their fingers into the water, they were surprised to find it as hot almost as if it had been boiling. The stones on shore, and the rocks exposed to the ebbing of the tide, were smoking and hissing, and the water bubbling all round them. The cone appeared from hence about one-fourth of a mile distant. Having landed in a cove, they ascended a precipice, holding by the grass that grew out of the ashes, and having reached the top, after no slight danger, they found a small tree, under the shade of which they had a full view of the volcano. Its height is about *half* a mile. The diameter of the base is supposed to be about 300 yards, and about 30 at the top, the whole of the space seeming to be occupied with the mouth. It discharged continually a thin white smoke. The cone stands in the centre of an amphitheatre of hills, which nearly close around it. In order to examine the crater, Captain W. ascended thirty or forty yards, sinking ankle deep in ashes at each step, but he found it impossible to reach the mouth. A full account of the Volcano will probably appear in the 15th volume of the *Asiatic Researches*.

31. *Population of the Principal Cities of Hindostan.*—The following is an approximate estimate of the principal cities of Hindostan:

Benares,	600,000	Moorshedabad,	150,000	Bareilly,	60,000
Calcutta,	500,000	Pound,	120,000	Burdwan,	54,000
Surat,	450,000	Nagpoor,	100,000	Bangalore,	50,000
Madras,	300,000	Baroda,	100,000	Chupra,	43,000
Lucknow,	200,000	Ahmedabad,	100,000	Seringapatam,	40,000
Hydrabad,	200,000	Cashmere,	100,000	Broach,	33,000
Dacca,	180,000	Furruckabad,	70,000	Mangalore,	30,000
Bombay,	170,000	Mirzapore,	69,000	Palhampour,	30,000
Delhi,	150,000	Agra,	60,000		

The total population of Hindostan is estimated at 134,000,000, and 1,280,000 square miles.—See *Asiatic Journal*, May 1823, vol. xv. p. 443, 444.

32. *Atlas of the Russian Empire.*—The new atlas of the Empire of Russia, the Kingdom of Poland, and the Grand Duchy of Finland, is now finished. This work, completed under the direction of Colonel Pladischef, is magnificently engraved, and consists of seventy plates, in large folio.—See *Journal des Voyages*, vol. xvii. p. 144.

33. *Population of the United States.*—The following Table shews the population of the United States of North America in the year 1820:

States.	Population in 1820.	Square Miles.	Persons in a square mile.
Maine,	298,335	32,628	7.01
New Hampshire,	244,161	9,491	22.60
Massachusetts,	523,287	6,250	75.53
Rhode Island,	83,059	1,580	48.69
Connecticut,	275,248	4,674	56.04
Vermont,	235,764	10,237	21.29
New-York,	1.372,812	46,085	20.81
New Jersey,	277,575	8,320	29.51
Pennsylvania,	1,049,458	46,800	17.31
Delaware,	72,749	2,120	34.28
Maryland,	407,350	14,000	27.18
Virginia,	1,065,366	70,000	13.92
North Carolina,	638,829	48,000	11.57
South Carolina,	502,741	24,080	17.24
Georgia,	340,989	62,000	4,07
Alabama,	127,901	46,000	0.72
Mississippi,	75,440	45,500	0.98
Louisiana,	153,407	48,220	1.80
Tennessee,	422,613	40,000	6.54
Kentucky,	564,317	39,000	10.42
Ohio,	581,434	40,000	5.77
Indiana,	147,178	34,000	1.99
Illinois,	55,211	56,122	0.62
Missouri,	66,586	445,334	0.11
Michigan Territory,	8,896	164,000	0.07
Arkansas Territory,	14,246	76,961	0.12
Territory of Columbia,	180,114	240,230	
Columbia, district of the Seat of Government,	33,039	100,000	
Floridas,	4,000	35,000	
Total,	9,637,999	1,637.424	

This population is composed of

			Total.
Whites,	Males,	3,995,053	7,861,710
	Females,	3,866,657	
Persons of Colour,	Males,	112,770	238,161
	Females,	125,391	
Slaves,	Males,	788,028	1,538,128
	Females,	750,100	
			9,637,999

34. *Population of Rome in* 1821 *and* 1822.—The population of Rome in the spring of 1821, amounted to 135,171 souls,

and at the same season in 1822, it amounted to 136,085, being an increase of 914 persons

ART. XXVI.—*List of Patents granted in Scotland from 6th March to 3d June* 1823.

7. TO WILLIAM PALMER of Lothbury, in the city of London, paper-hanger, for an invention of certain "improvements in machinery, for the purpose of printing or staining paper for paper-hangings." Sealed at Edinburgh 4th April 1823.

8. To ROBERT WINTER, of Fen Court, London, Esq. for an invention of "an improved method of conducting the process of distillation." Sealed at Edinburgh 28th April 1823.

9. To SAMUEL HALL of Basford, county of Nottingham, cotton-spinner, for an invention of "a certain method of improving lace, net, muslin, calico, and any other description of manufactured goods, whose fabric is composed of holes or interstices; and also thread or yarn, as usually manufactured, of any kind, whether the said manufactured goods, or the said thread or yarn, be fabricated from flax, cotton, silk, worsted, or any other substance or mixture of substances whatsoever." Sealed at Edinburgh 7th May 1823.

10. To WILLIAM MITCHELL, jeweller in Glasgow, for an invention "of a process, whereby gold and silver plate, and any other plate formed of ductile metals, may be manufactured in a more perfect and expeditious manner, than by any process which has hitherto been employed in such manufacture." Sealed at Edinburgh 12th May 1823.

11. To JOSEPH WOOLLAMS, of the city of Wells, county of Somerset, land-agent, for an invention "of certain improvements in wheeled carriages of various descriptions, to counteract the falling, and facilitate the labour, of animals attached to them, and to render persons and property in and near them more secure from injury." Sealed at Edinburgh 3d June 1823.

12. To CHARLES MACKINTOSH, Esq. of Crossbasket, county of Lanark, for an invention of "a process of manufacture, whereby the texture of hemp, flax, wool, cotton and silk, and also leather, paper, and other substances, may be rendered impervious to water and air." Sealed at Edinburgh 3d June 1823.

P. NEILL, Printer.

THE

EDINBURGH PHILOSOPHICAL JOURNAL.

Art. I.—*Biographical Notice of M. Le Chevalier* Delambre, Perpetual Secretary for the Mathematical Sciences in the Institute of France, Member of the Board of Longitude, Professor of Astronomy in the College of France, Officer of the Legion of Honour, and one of the Honorary Members of the Royal Society of Edinburgh, &c. &c. *.

M. Delambre, one of the most learned and active astronomers of the last century, was born at Amiens on the 19th September 1749. At the Gymnasium of that town, he acquired his knowledge of the Latin and Greek languages, and had the honour of being a pupil of the celebrated French poet the Abbé Delille. When Delambre was pursuing his studies at his native place, the expulsion of the Jesuits from France left vacant several of the professorships in the College, and these vacancies were filled by Professors sent from Paris. Among these was the Abbé Delille, a Repeater of Syntax in the College of Beauvais, who had already attempted to translate the Georgics of Virgil. The citizens of Amiens, who were attached to the interests of the Jesuits, refused to admit the new Professors into their society, and Delille was thus left to associate only with his pupils. Under these circumstances, he soon distinguished Delambre, and a friendship thus commenced between the mas-

* This notice has been drawn up from an Eloge of Delambre written in Dutch by our learned correspondent Professor Moll of Utrecht, who was one of his pupils, and from M. Dupin's *Notice Necrologique sur M. Delambre*, published in the *Revue Encyclopedique*, December 1822.

ter and his pupil, which was afterwards renewed in Paris, and which terminated only with the life of the poet.

In the year 1782, in the thirty-third of his age, M. Delambre became acquainted with the celebrated French astronomer Lalande, who observing his aptitude for the study of astronomy, advised him to devote his attention to that science. Influenced by this advice, he became the pupil of Lalande, who afterwards used to say that Delambre was his best work.

One of the first papers published by Delambre was his account of the occultation of Venus on the 12th April 1785, which appeared in the 3d volume of the *Nova Acta Petropolitana;* and in the same year he contributed to the Memoirs of the Academy of Berlin a dissertation on the Elements of the Solar Orbit,—a subject which he afterwards pursued with such distinguished success. The greater number of our author's papers, however, were published in the *Connaissance des Tems;* and from 1788 to 1817, almost every volume was enriched with a valuable memoir from his pen.

The discovery of the Georgium Sidus by Dr Herschel in 1781, directed the attention of astronomers to the determination of its orbit. In this new field, Delambre obtained great distinction. He constructed the most accurate tables of the motion of the new planet; and in 1790, the prize given by the French Academy was awarded to him for these labours. In 1792, he obtained another prize for his Tables of the Satellites of Jupiter; and he soon afterwards presented to the same learned body his Tables of the Motions of Jupiter and Saturn. In consequence of these valuable contributions to the science of astronomy, he was unanimously chosen a member of the Academy of Sciences in 1792. In the same year, he was appointed, along with Mechain, to measure an arc of the meridian between Dunkirk and Barcelona, an operation which, though often interrupted by the events of the Revolution, was finished in the most successful manner in 1795. An account of this great undertaking he afterwards published in his *Methodes Analytiques pour la determination d'un Arc du Meridien,* one volume 4to, 1799, and in his *Base du Systeme Metrique decimal,* which appeared in three volumes quarto, from 1806 to 1814. These valuable works could not fail to obtain the highest approbation from the Insti-

tute; and accordingly that learned body decreed to him in 1810 one of the decennial prizes which had been instituted by Bonaparte. But as the Emperor refused to deliver the prizes * which he had himself established, Delambre obtained only the honour of its adjudication.

Previous to this measurement, the French academicians had not distinguished themselves in the practical parts of astronomy. Among the members of the Academy which were sent to measure an arc of the meridian in Lapland, the Abbé Outhier is said to have been the only one of them who understood the method of taking corresponding altitudes with the quadrant which was then used. The results of the measurement were such as might have been expected, under such circumstances Even Lagrange, whom Bonaparte used to call *le Racine de la Geometrie*, was so little acquainted with the practical part of astronomy, that he requested Lalande to explain to him the use of the Zenith Sector and the Mural Quadrant †.

Delambre had therefore peculiar merit in executing, in so superior a manner, the great trigonometrical operations which were entrusted to him; and he is entitled also to the still higher praise of having set an example which has been followed by so many of the other nations of Europe.

In the year 1795, M. Delambre was appointed one of the Members of the Board of Longitude, and a Member of the First Class of the Institute of France. When Bonaparte became First Consul, Delambre was appointed Inspector-General of Studies; and, in this capacity, he organised the Lyceum of Moulins in 1802, and that of Lyons in 1803, in a manner which reflected the highest credit on his intelligence and good feelings.

In the year 1807, upon the death of his preceptor and friend Lalande, Delambre was appointed Professor of Astronomy

* "Napoléon," says M. Dupin, "après avoir annoncé les prix décennaux avec un faste imposteur, refusa de les délivrer, lorsque le choix qu'il avait demandés eurent été faits par l'Institut, et publié à la face de toute la France. Il montra dès lors que ses pensées s'étaient tournées vers un autre but que celui du progrès de la civilisation des peuples; ce fut un pas dans la route qui le menait à sa chute."

† These anecdotes are given on the authority of Professor Moll, who had the last from Delambre himself.

in the College of France. In this situation, he found himself associated with his former master M. Delille, who had been appointed to the professorship of Latin Poetry. This eminent poet, who was now old and blind, was obliged to appoint a deputy to discharge the duties of his office. In 1812, when he had been particularly indisposed, and when great fears had been entertained for his life, he made an unexpected recovery, and resolved to give the first lecture at the opening of the course. Although the lecture did not begin till one o'clock, the doors of the lecture-room were closely beset so early as eleven, and the other Professors found themselves deserted. The crowd had become so great at twelve, that the soldiers who guarded the entrance were pushed from their places, and the crowd filled the lecture-room. On this interesting occasion, the old blind poet was led to the chair by his favourite pupil Delambre, and by M. Lefevre Gineau.

In the year 1808, M. Delambre was appointed Treasurer of the Imperial University; and upon the return of the Bourbon family, he was nominated in 1814 a Member of the Royal Council of Public Instruction, a place which he lost in 1815 The following extract of a letter which he wrote to his friend and pupil Professor Moll in 1814, relative to the taking of Paris in 1814, will be read with considerable interest: "I hasten to inform you, that the events which have followed each other in such rapid succession during this last month, have not yet directly affected me. On the very day of the siege, in spite of the cannonade which I heard from my library, I laboured with tranquillity from eight in the morning till midnight. I was well persuaded that they would not push their folly so far as to defend the town long, and that they would open their gates to the Allies, who would pique themselves on their generosity. Some days afterwards, I saw foreign troops cover the Quays of Paris, pass under my windows, and fill all the streets and Boulevards; but no military man has ever been billeted upon me. Not having a country-house in the vicinity of Paris, like some of my colleagues, I have not had to lodge or feed any officer or soldier, or any horses. The devastation has not come near me. The future does not offer a very brilliant prospect to philosophers; but they ought to know how to content them-

selves with little. Labour occupies all my time and all my faculties. My happiness does not depend on having a little more leisure; and I should have very little change to make in my personal habits."

At the creation of the Legion of Honour, M. Delambre was made a member of that order. He was appointed Chevalier of St Michael in 1817; an Officer of the Legion of Honour in 1821; and a long time before he was created a Hereditary Chevalier, with a dotation, which was decreed as a national reward.

In the midst of these honours, Delambre was carried off from his friends on the 19th of August 1822, in the seventy-third year of his age. An eloge, full of eloquence and fine feeling, was pronounced over his tomb by Baron Cuvier, in the name of the Institute; and a similar mark of respect was paid to his memory by the College of France and the Board of Longitude.

His place in the Institute, as Perpetual Secretary of the Academy of Sciences, has been filled by an eminent philosopher Baron Fourrier, formerly Secretary to the Egyptian Institute, author of the *Mathematical Theory of Heat*, and of the Introductory Preface to the great work on the Description of Egypt.

The great extent of the labours of Delambre will be seen from the list of his writings which accompanies this notice; but the full value of them can only be appreciated by those who are profoundly acquainted with the subjects of which they treat. The services which he rendered to astronomical science, though not gilded with any brilliant discovery, possess a value far beyond those which are characterised principally by their novelty. His Tables of the Sun, and those of Saturn, the Georgium Sidus, and Jupiter and his Satellites, are the result of immense labour, and are marked with a degree of precision far beyond the expectations of the most sanguine astronomer. His *Traité d'Astronomie Theorique et Pratique*, in three volumes, and his *Histoire de l'Astronomie Ancienne*, in two volumes, his *Histoire de l'Astronomie du Moyen Age*, in one volume; and the two first volumes of his *Histoire de l'Astronomie Moderne*, are works

of great judgment and erudition, and will maintain their value as long as the science of the heavens is cultivated.

To a profound knowledge of science, Delambre added the rare accomplishment in a scientific man, a deep knowledge of ancient and modern languages. He was so thoroughly acquainted with the Greek language, that he could speak it as fluently as his native tongue; and it is impossible to read his History of Ancient Astronomy, without admiring the advantages which this acquirement has given him over all the other historians of science. He also read English, Italian and German, with fluency; and though his erudition was principally directed to the purposes of science, yet he often relaxed from his severer labours in the study of Virgil, Homer, Plutarch and Cicero.

In his scientific character, Delambre was universally admired. In private life, he displayed the most amiable dispositions; and as a public man, he was attached to those sacred and social institutions which form the bulwark of civil society. In all his writings, and especially in his History of Astronomy, he has invariably declared his conviction that the Mosaic history is in no respect invalidated by any facts in the ancient astronomy, and that the date of those facts does not remount to a remote period. Many good and pious men, indeed, have maintained the antiquity of the Indian Astronomy, and supported geological opinions which carry back to a remote era the formation of our existing globe; and even learned theologians have endeavoured to accommodate Revelation to what they supposed to be scientific truth, by ingenious interpretations of the Sacred Scriptures. But there has been another set of men, actuated by quite different motives. When ridicule had lost its efficacy, and sophistry its force, they embarked in the more daring scheme, of arraying against the records of Revelation the eternal truths of the natural world. This war of science has been sustained during the last thirty years with singular zeal and dexterity; and though its success among the young and the ignorant has [illegible] by which they have been totally overpowered. The antiquity of the Indian Astronomy has been put down by the united decision of Laplace, Ivory, and Delambre; while Werner, Cuvier, Deluc,

Kirwan, Humboldt, Mohs, and Buckland, have all concurred in considering the geological antiquity of the globe as incompatible with the phenomena which actually exist upon its surface *.

The following is a List of the Writings of Delambre, as given by Professor Moll:

In the Connaissance des Tems.

1788, Longitudes et Latitudes de 998 étoiles du Catalogue de Mayer.

1789, Nouveaux Elémens pour le Soleil.

1790, Tables d'Aberration.

1798, Tables du Mouvement horaire de la Lune.

An 11, Méthode pour tenir compte de l'Excentricité de l'orbite terrestre dans le calcul de l'Aberration.

12, Reduction de la Distance apparente à la Distance vraie dans le Calcul des Longitudes.

— Remarques sur la Formule de Borda, pour changer en Distance vraie la Distance apparente de la Lune au Soleil ou à une Etoile.

— Formules pour le Réticule Rhomboïde.

13, Des Latitudes croissantes dans le Sphéroide.

— Rapport fait au Bureau des Longitudes sur les Tables de M. Burg

14, Formules nouvelles pour la réduction des distances apparentes de la Lune au Soleil ou aux Etoiles en distances vraies.

1808, Tables pour trouver les Configuration des Satellites de Jupiter.

— Histoire d'Astronomie pour 1804 et 1805.

1810, Methodes pour trouver les Corrections des passages observés à la lunette méridienne.

1811, Methode pour trouver la Latitude et le Tems par l'observation de deux étoiles connues.

* Upon this subject, we would strongly recommend, both to the scientific and general reader, a perusal of Granville Penn's *Comparative Estimate of the Mineral and Mosaic Geology*, a work of singular ingenuity and interest.

1812, Sur la solution nouvellement donnée par M. Gauss d'un problême d'Astronomie sphérique, dans lequel on se propose de déterminer tout à la fois la latitude du lieu, la correction de la pendule, et celle d'un instrument par les hauteurs égales de trois étoiles connues.

—— Sur les différens moyens employés par les Astronomes pour observer les Eclipses de Soleil.

—— Nouvelles Remarques sur le Calcul des Parallaxes, et sur les Formules de MM. Olbers et Littrow.

1816, Hipparque a-t-il observé à Alexandrie?

—— Meridienne d'Uranibourg.

—— De l'Optique de Ptolomée, comparée á celle qui porte le nom d'Euclide, d'Alhazen, et de Vitellon.

1817, Nouvelles Recherches sur les Methodes qui servent à trouver la Latitude par deux hauteurs d'un même astre hors du méridien.

—— Formules pour Calculer la Lettre Dominicale, le Nombre d'Or, l'Epacte, et la Fête de Paques, pour une année Gregorienne ou Julienne quelconque.

1818, Problême de Regiomontan.

—— De Nonius, et de ses Formules pour les Crépuscules.

1819, Theorie purement analytique de l'Analemme Rectiligne universel et particulier, avec des conjectures sur les moyens dont se servaient les Arabes pour trouver l'heure.

1819, Formules pour déterminer la parallaxe d'un astre d'après les premières observations.

—— Des Formules qui servent à passer directement du lieu Héliocentrique à l'Ascension Droite, et à la Declinaison Géocentrique d'une Planete ou d'une Comete.

The following are the Papers which he published in the Memoirs of foreign Academies:

In the Memoirs of the Academy of Stockholm,

Sur le Calcul des Parallaxes. 1788.

In the Nova Acta Petropolitana,

Sur l'Occultation de Venus observée le 12. Avril 1785.

In the Memoirs of the Academy of Berlin,

Sur les Elémens de l'Orbite Solaire. 1785.

In the Memoires of the Academy of Turin,

Formules nouvelles pour déterminer le maximum de la Réduction à l'Ecliptique. Tom. iv.

De l'Usage du Calcul Différentiel dans la construction des Tables Astronomiques. Tom. v.

In the Memoirs of the First Class of the Institute of France,

Passage de Mercure sur le Soleil, observé le 18. Floréal, an 6. Tom. iii.

Rapport sur la Description d'un Astrolabe de Synesius. Tom. v.

Rapport sur les grandes Tables Trigonométriques Décimales du Cadastre. Tom. v.

De la Projection Stéreographique. Tom. v.

Sur un cadran trouvé à Délos, et par occasion de la gnomonique des anciens. Tom. pour 1813, 1814, 1815.

He wrote also in the Memoirs of the Institute, Eloges of Mechain, tom. vi. Brisson (1806), Coulomb (ditto.), Lalande (1807), Ferdinand Berthoud (1808), Montgolfier (1810), Bougainville (1811), Maskelyne (1806), Fleurieu (1816), Bossut (1816), L'Evêque (1816); and in the Memoirs of the Academy of Sciences, those of Malus (1812), Lagrange (1812), Rochon (1817), Messier (1817), and Percier (1818).

The following are his separate works:

An 7, Méthodes analytiques pour la Détermination d'un Arc du Méridien. 1 Vol. 4to.

An 9, Tables Trigonométriques Décimales, ou Tables des Logarithmes des Sinus, Secantes et Tangentes, suivant la division du quart de cercle en cent dégrés, et précédées de la table des logarithmes des nombres calculées par Ch. Borda, revues, augmentées et publiées par M. Delambre. 1 Vol. 4to.

1806, 1810, Base du Système Métrique Decimal. 3 Vols. 4to.
1806, &c. Tables publiées par le Bureau des Longitudes de France.
Tables du Soleil, par M. Delambre. 1 Vol. 4to.
Tables de Jupiter, d'après la theorie de M. Laplace, et la totalité des observations depuis 1662 jusqu'à 1802. 1 Vol. 4to.
Nouvelles Tables écliptiques des Satellites de Jupiter d'après la théorie de M. Laplace, et la totalité des observations depuis 1662 jusqu' à 1802. 1 Vol. 4to.
1813, Traité d'Astronomie théorique et pratique. 3 Vols. 4to.
Abrégé ou Leçons Elementaires d'Astronomie théoretique et pratique. 1 Vol. 8vo.
1817, Histoire de l'Astronomie Ancienne. 2 Vols. 4to.
1819, Histoire de l'Astronomie du Moyen Age. 1 Vol. 4to.
1821, Histoire de l'Astronomie Moderne. 2 Vols. 4to.

The third and last volume of his History of Modern Astronomy was almost, if not wholly, finished at the time of his death, as appears from the following extract of a letter addressed to Professor Moll: "I have almost finished the 3d volume, which will be entitled the *Astronomy of the Eighteenth Century*, and which will terminate with the labours of Maskelyne. It will embrace in a separate book the History of the Measurement of the Earth, from that of 1700 to the time when the volume shall appear. In these three volumes, I have told only what is true, and nothing which is not capable of being proved; but I have at the same time told the whole truth. I anticipate that I shall be considered as sometimes severe; but I have taken my resolution. In ordinary life, I listen to every thing, without disputing with any person; but I have made up my mind, after a long and severe examination, and I wish to discharge a duty to my conscience. My work attacks no living author; and if any one cavils with me, it must be in favour of some of the illustrious dead, whose errors he is anxious to cover, or whose merit he wishes to exaggerate, by attributing to him what he has not done, and what he has borrowed without acknowledgment from others."

Art. II.—*Observations on Changeable Stars, and Stars of different Colours.*

THERE is no branch of astronomy more pregnant with interest than that of stars which shine with a variable and periodical lustre. Our countryman Mr Pigott was the first astronomer who devoted his attention to this class of phenomena. He established the existence of fifteen stars which shine with a variable light, and gave a catalogue of observations on thirty-seven stars which he suspected to have the same property. Sir William Herschel made many valuable observations on the same subject, the results of which are to be found even in our popular treatises on astronomy.

Three German astronomers, M. Struve of Dorpat in Livonia, and MM. Harding and Westphal of Gottingen have recently been engaged in the observation of periodical stars. M. Struve has begun to publish his results in the Collection of his Astromical Observations for 1818 and 1819, which appeared at Dorpat in 1821. He there describes stars of all colours *, white, yellow, blue, and red, with all their different shades. He has determined also the constant of aberration for several of these stars, of all magnitudes and colours, and, from finding the same result, he concludes that they all project their light with the same velocity.

M. Harding has discovered several new variable stars; and M. Westphal has published his observations on the same subject in Lindenau and Bohnenberger's Astronomical Journal. Unfortunately for science, a valuable memoir on changeable stars, which he had composed in 1817 for the above work, was lost at the printing-office.

The following catalogue of twenty-eight changeable stars has been recently published by Baron de Zach in his *Correspondence Astronomique*, vol. viii. p. 99.

* His terms are, alba, obscura, obscurissima, livida, pallida, flava, subflava, cœrulea, subcœrulea, rubra, rubicunda. &c.

Catalogue of Twenty-eight Changeable Stars.

	Names of Stars.	Right Ascension in 1800.	Declination in 1800.
	46 Andromeda, -	1h 11′	44° 29′ N.
	ο Balænæ *Mira*, -	2 09	3 54 S.
	β Persei *Algol*, -	2 55	40 11 N.
	Unicorn, - -	6 13	3 51
5	23 γ Canis Major, -	6 55	15 21
	16 ψ Leonis, - -	9 33	14 56
	Leo 420 Mayer, -	9 37	12 21
	16 *c* Virgo, - -	12 10	4 26 N.
10	Virgo, - -	12 28	8 06 N.
	Virgo, - -	13 04	15 28 S.
	u Hydra, - -	13 19	22 15 S
	97 Virgo, - -	14 02	8 57 S.
	Bootes, - -	14 04	12 57 N.
	1 Libra A, - -	14 05	26 19 S.
15	Virgo, - -	14 37	2 53 N.
	50 Northern Crown,	15 40	28 47 N.
	31 Hercules, -	16 24	33 57 N.
	α Hercules, - -	17 06	14 38 N.
	59 Sobieski's Shield,	18 37	5 54 S.
20	β Lyra, - -	18 43	33 08 N.
	34 σ Sagittarius, -	18 43	26 32 S.
	χ Swan, - -	19 39	33 16 N.
	Swan No. 295. P. -	19 41	32 57 N.
	η Antinous, - -	19 42	0 30 N.
25	Southern Fish, -	19 43	33 08 S.
	34 Swan, near γ, -	20 10	37 25 N.
	δ Cepheus, - -	22 22	57 23
	Aquarius, - -	23 24	16 23

Of this catalogue of Variable Stars, Nos. 2, 3. 7. 11. 18, 19, 20. 22. 24, and 26. belong to the list of fifteen as given by Mr Pigott. Some of the others belong to the list of those which he suspected to be variable.

Art. III.—*Account of the Caves at Kirby Moorside, and the open fissure in Duncombe Park, with notices of the other Caves in England.*

Having, in a previous Volume, (Vol. VIII. p. 56.), laid before our readers a brief account of the celebrated cave of Kirkdale in Yorkshire, and of the great cave of Gailenreuth in Franconia, we are now enabled, by the publication of the Reverend Mr Buckland's *Reliquiæ Diluvianæ*, to continue these interesting papers.

The able and valuable work of Mr Buckland, which we cannot recommend too strongly to the perusal of our readers, and especially to those who have been disposed to draw a line between Science and Revelation, is divided into two parts. Part I. contains a full account of all the caves in England and Germany, which contain organic remains; and Part II. a detail of the evidences of an Universal Deluge, as afforded by phenomena actually existing on the surface of the earth. To the First Part the author has added notices of the osseous breccia in Gibraltar, Nice, Dalmatia, &c.; and of the human remains in caves: and to the Second Part, he has added the opinion of Cuvier, and an appendix on the excavation of valleys by diluvial denudations.

As we propose to continue this subject solely as a branch of Physical Geography, we shall proceed to the description of the caves of Kirby Moorside.

Caves at Kirby Moorside.

"The cave at Kirby Moorside was intersected in working the face of a quarry of the same limestone as that at Kirkdale, at the north end of the town, and on the right side of a narrow gorge or valley called the Manor Vale, which descends from the north towards the Vale of Pickering, nearly parallel to the valley of Kirkdale, being about sixty feet broad, and bounded by slopes forty feet high, and forming one of the many smaller valleys of denudation excavated on this limestone, by the diluvial waters, as they subsided from the moorlands to the Vale of Pickering. A considerable portion of the right bank of this valley

has been laid bare by the workings of the quarry, and on the face of it there are traces of a fissure connected with several small cavernous holes. The aperture discovered last spring is in the centre of this quarry, and near its floor. On removing the wall with which Mr Duncombe had caused it to be closed, it was found to pass obliquely into the body of the hill, and to be intersected at a few feet from its entrance by a large fissure. This point of intersection forms, as at Kirkdale, the widest and most lofty part of the cavern, within which it diminishes into smaller vaults, which soon become impassable: the outer part of the cave when first opened was about four feet high and six broad, and its entire floor covered with an uniform mass of loamy clay, precisely similar to that on the floor of the den at Kirkdale. On digging into this loam it was found to be six feet deep for a considerable distance inwards, and to contain no bones. At its bottom there was no stalagmitic under-crust dividing it from the limestone floor, nor any repetition or alternation of a second or third bed of stalagmite in any part of its substance. Its surface alone was in many parts glazed over with an extensive sheet of it oozing outwards from the side walls, and sometimes entirely crossing and forming a bridge over the loam. Above this crust some parts of the roof and sides were loaded with stalactite in its usual fantastic forms; but there were no bones of modern animals, nor traces of loam, or even of dust, upon the surface of the superficial crust of stalagmite. In all its circumstances, as far as they went, it agreed with, and confirmed the history and chronology I have given of the cave at Kirkdale, excepting the two accidents of its not having been inhabited as a den, or received any stalagmite on its floor, before the introduction of the diluvial loam. The absence of bones in this cave (the mud being present) adds to the probability that it was by the instrumentality of the hyænas, and not of the diluvial waters, that the animal remains were collected in such quantities in the adjacent den at Kirkdale.

"At about a mile east of Kirby Moorside, at a spot called the Back of the Parks, there are other quarries on both sides of a comb that descends rapidly into the valley of the Dove, in the face of which there occur several small caverns and vertical fissures: these fissures vary from one to six feet in breadth, and

rise from the bottom of the quarry to the surface of the land, and are entirely filled with diluvial loam of the same kind as that in the caves both here and at Kirkdale, and the Manor Vale. It was in the upper part of one of the fissures that several human skeletons were found and taken out in the year 1786, but the spot on which they occurred has been destroyed in continuing the workings of the quarry: they were probably bodies that had been interred here after a battle."

Open Fissure in Duncombe Park.

"The newly discovered fissure in Duncombe Park differs from those we have been last describing, in the circumstance of its being of postdiluvian origin; it contains no diluvial sediment and no pebbles, and has within it the remains of animals of existing species only, and these in a much more recent and more perfect state of preservation than the bones at Kirkdale. It is a great irregular crack or chasm, in the solid limestone rock, which forms a steep and lofty cliff on the right side of the valley of the Rye, being in that most beautiful valley of denudation which descends from Rivaulx Abbey through Duncombe Park to the town of Helmsley, and on the left bank of which are the magnificent terraces of Rivaulx Abbey, and of the gardens at Duncombe Park. The crack has probably been formed by a subsidence of part of the cliff towards the valley, and terminates upwards near its edge in a small aperture, about twenty feet long and three or four feet broad, which is almost concealed and overgrown with bushes, and which being nearly at right angles to the edge of the cliff, lies like a pitfall across the path of animals that pass that way. It decends obliquely downwards, and presents several ledges or landing places and irregular lateral chambers, the floors of which are strewed over with loose angular fragments of limestone, fallen from the sides and roof, and with dislocated skeletons of animals that have from time to time fallen in from above and perished. One of Mr Duncombe's game-keepers had been for many years aware of the existence of bones in this chasm, but had never mentioned it till my second visit to Duncombe Park, when we examined it, descending by means of a rope, and found it to contain the skeletons of dogs, sheep, deer, goats, and hogs, lodged at vari-

ous depths on the landing-places I have just mentioned: the bones lay loose and naked on the actual spots on which the animals had died, and to which they had probably fallen when passing carelessly along the surface of the Park above; they were neither broken, nor buried in loam, nor incrusted with stalagmite, as at Kirkdale, but simply stripped of their flesh; they are not adherent to the tongue when fractured, but retain much more animal matter, and are in all respects more fresh and recent, than those which occur at Kirkdale entombed beneath the loam.

"In a geological point of view, the occurrence of these bones, under the circumstances above described, is important, as illustrating the manner in which the bones of antediluvian animals may have been accumulated by falling into similar fissures, which are now filled up with diluvial mud and pebbles; for if fissures existed (as they undoubtedly did) on the antediluvian face of the earth in much greater abundance than since that grand aqueous revolution, which has entirely filled up so many of them with its detritus, there is no reason why the then existing animals should not have fallen into them and perished, as modern animals do in the comparatively few cavities that remain still open in our limestone districts: and when we consider that it is the habit of graminivorous animals to be constantly traversing the surface of the ground in every direction in pursuit of food, it is obvious that they are subject in a greater degree than those which are carnivorous to the perpetual danger of falling into any fissure or imperfectly closed chasm that may lie in their way; and in this circumstance we see an explanation of the comparatively rare occurrence of the remains of beasts of prey in the osseous breccia of the antediluvian fissures, although they also occasionally perished in them, as the dogs do at this day in the open fissure at Duncombe Park."

The caves now mentioned by our author are:

1. The Cave at Hutton in the Mendip Hills.
2. The Cave at Derdham Downs, near Clifton.
3. The Cave at Balley, near Wirksworth.
4. The Dream Cave, near Wirksworth.
5. Three sets of Caves near Plymouth.

6. The Cave at Crawley Rocks, near Swansea.

7. The Cave at Paviland, near Swansea.

1. *The Cave at Hutton.*—This cave is one of many cavities of mountain limestone, which were lined and nearly filled with ochreous clay. The bones found in it were the teeth and bones of the elephant, and some few remains of horses, oxen, and two species of stag, besides the skeleton of a fox, and the metacarpal bone of a large species of bear, and the molar teeth and tusk of a large hog. Mr Buckland supposes that these bones were not dragged in by beasts of prey, but were either drifted in by the diluvian waters, or derived from animals that had fallen in before the introduction of the ochreous loam, which is clearly of diluvian origin.

2. *Cave on Derdham Downs.*—This cavity in mountain limestone contains fractured bones, partially encrusted with stalactitical matter, and the broken surfaces have also an external coating of thin vitreous stalactite, proving the fracture to have been ancient. One specimen is the fossil joint of the horse. "It is," says Mr Buckland, "the tarsus joint, in which the astragalus retains its natural position between the tibia and os calcis; these are held together by a stalagmitic cement, and were probably left in this position by some beast of prey that had gnawed off the deficient portions of the tibia and os calcis."

3. *Cave at Balley.*—This cavity of mountain limestone was intersected in working a lead-mine, and contained some bones and molar teeth of the elephant.

4. *Dream Cave.*—This cave was discovered in December 1822, in the pursuit of a lead-vein through solid mountain limestone. It was filled with a confused mass of argillaceous matter and fragments of stone, in the middle of which was found nearly the whole skeleton of a rhinoceros, and some remains of the ox and the deer. Mr Buckland infers that these bones were derived from animals that perished by the same waters that introduced them to the cave.

5. *Caves near Plymouth.*—An account of some of these caves has already appeared in the Philosophical Transactions for 1817 and 1821, and some of the others will be described in the volume for 1823.

The bones of horses, oxen, hyænas, deer, and wolves, have been discovered in these caves in great quantities. Mr Buckland is of opinion, that the animals had fallen during the antidiluvian period into the open fissures, and there perishing, had remained undisturbed in the spot on which they died, till drifted forwards by the diluvian waters to their present place in the lowest vaultings with which these fissures had communication.

6. *Cave at Crawley Rocks.*—This cavity is in Oxwich Bay, about twelve miles SW. of Swansea, in a quarry of limestone. The bones found in it were those of the elephant, rhinoceros, ox, stag, and hyæna. They have a slight ochreous incrustation.

7. *Cave of Paviland.*—There was lately discovered, about fifteen miles north of Swansea, two large caves, facing the sea, on the front of a lofty cliff of limestone, which rises more than 100 feet perpendicularly above the mouth of the caves, and below them slopes at an angle of about 40° to the water's edge. In the principal one, called the Goat's Hole, Mr Buckland found bones of the elephant, rhinoceros, horse, stag, bear, hyæna, fox, wolf, ox, deer, rat, birds, and a portion of that of a woman clearly postdiluvian. Rods and rings of ivory, a skewer of bone, charcoal, and fragments of recent bones, were also found. The remains of a British camp exist on the hill immediately above the cave.

The other cavern, also explored by Mr Buckland, is about 100 yards farther to the west, and is very similar to the first in size, form, and position.

Mr Buckland concludes his account of the English caves with the following observations:

"The above facts are, I think, sufficient to warrant us in concluding, that in the period we have been speaking of, the extinct species of hyæna, tiger, bear, elephant, rhinoceros, and hippopotamus, no less than the wolves, foxes, horses, oxen, deer, and other animals which are not distinguishable from existing species, had established themselves from one extremity of England to the other, from the caves of Yorkshire to those of Plymouth and Glamorganshire; whilst the diluvial gravel-beds of Warwickshire, Oxford, and London, show that they were not wanting also in the more central parts of the country; and M.

Cuvier has established, on evidence of a similar nature, the probability of their having been spread in equal abundance over the Continent of Europe. But it by no means follows, from the certainty of the bones having been dragged by beasts of prey into the small cavern at Kirkdale, that those of similar animals must have been introduced in all other cases in the same manner; for as all these animals were the antediluvian inhabitants of the countries in which the caves occur, it is possible that some may have retired into them to die, others have fallen into the fissures by accident and there perished, and others have been washed in by the diluvial waters. By some one or more of these three latter hypotheses, we may explain those cases in which the bones are few in number and not gnawed, the caverns large, and the fissures extending upwards to the surface; but where they bear marks of having been lacerated by beasts of prey, and where the cavern is small, and the number of bones and teeth so great, and so disproportionate to each other as in the cave at Kirkdale, the only adequate explanation is, that they were collected by the agency of wild beasts. We shall show hereafter, that in the case of the German caves, where the quantity of bones is greater than could have been supplied by ten times the number of carcases which the caves, if crammed to the full, could ever have contained at one time, they were derived from bears that lived and died in them during successive generations.

" Although it must appear probable from the facts I have now advanced, that similar bones abound generally in the caves and fissures of our limestone districts, we shall yet cease to wonder that their existence has been so long unnoticed, when we consider the number of accidental circumstances that must concur to make them objects of public attention. 1*st*, The existence of caverns is an accidental occurrence in the interior of the rock, of which the external surface affords no indication, when the mouth is filled with rubbish, and overgrown with grass, as it usually is in all places, excepting cliffs, and the face of stone quarries. 2*d*, The presence of bones is another accident, though probably not an uncommon one in those cavities which were accessible to the wild animals, either falling in, or entering spontaneously, or being dragged in by beasts of prey,

in the period immediately preceding the deluge. 3d, A further requisite is, the intersection of one of these cavities, in which there happen to be bones, by a third accident, viz. the working of a stone-quarry, by men who happen to have sufficient curiosity or intelligence to notice and speak of what they find, and this to persons who also happen to be willing or able to appreciate and give publicity to the discovery. The necessary concurrence of all these complicated contingencies renders it probable, that however great may be the number of subterraneous caverns, in an inland country, very few of them will ever be discovered, or if discovered, be duly appreciated. Those I have mentioned in Yorkshire, Devon, Somerset, Derby, and Glamorganshire were all laid open, with the exception of the caves at Paviland, by the accidental operations of a quarry or mine."

Art. IV.—*Account of a Map drawn by a native of Dawa or Tavay.* By Francis Hamilton, M. D. & F. R S. & F A. S Lond. & Edin. With a Plate Communicated by the Author

The accompanying Map, Plate V. was procured from the native of Dawa, mentioned in my account of the general map of the Empire of Ava *. He had been sent by the King of that country to Ceylon, in order to bring an account of the Temples at Anuradapura, the ancient capital of the island; and, when I arrived from Rangoun, was at Calcutta on his return. As I had an opportunity of shewing the man civilities and kindness, he gave me his assistance in arranging the geographical materials procured in Ava; and, being far from danger, spoke and wrote without fear or restraint. I have, however, to regret, that I omitted to procure all the names of places in the Mranma character. The Map was originally drawn on black paper, with a pencil of steatite, such as the Mranmas commonly use. A Mahommedan painter copied the outlines on paper, and I wrote the names in English letters, as the man read them from his black book. Afterwards he added the Mranma characters

* See this *Journal*, No. iii. p. 91.

to many of the considerable places; but, as he was not accustomed to write with our paper and pens, he did the work with difficulty, and many of the names were therefore omitted.

Between the shore of the Bay of Bengal and a chain of hills running through the centre of the Malay peninsula, a considerable portion of the country is occupied by a tribe, which, although it speaks a dialect of the Mranma language, has in general been subject to Siam. When I was in Ava, however, this tribe was subject to the King of the Mranmas. Formerly it had princes of its own, who resided at a city named Tanænsari by the Mranmas, and Tenasserim by Europeans, and on this account the tribe is usually called Tanænsari. Some time before the year 1784, this tribe had been separated from Siam, and reduced to the dominion of Ava; but soon after the Governor, enraged at the execution of his father, rebelled, and threw himself under the protection of Siam, by sending a handsome daughter as a present to the King of that country. The Siammese, however, were not able to retain possession, much to the regret of the inhabitants, but fled with little resistance before an army of Mranmas, sent in 1792, to expel them. In 1795, the country occupied by this tribe was divided into two Governments, Dawæ or Dhawæ and Breit, each under the authority of a Lieutenant (Zikkaeh) of the Viceroy (Mrowun) of Martaban or Moutama.

The Map now under discussion belongs properly to the Government of Dawæ alone, with which the compiler, being a native, was best acquainted; and this is marked by a dotted line, denoting the boundary between it and Breit towards the south, and between it and Kalinaun and Je or Ye on the north. Perhaps, therefore, in giving an account of this map, I should have confined myself entirely to the territory within this boundary; but as no opportunity is likely to offer, I think it best to say somewhat concerning the adjacent territories, some of which are laid down with tolerable detail in this Map.

In the first place, however, it is to be remarked, that the northern extremity towards Rangoun, Zittaun and Mouttama or Martaban, is merely a rude sketch, placed with a view to denote that such places are in that direction, and in a former

number of this Journal *, I have already stated what appeared necessary concerning these places. I have also mentioned †, that a city called Je or Ye, although laid down in a map by the native of Taunu on the island called Bhalu, at the mouth of Martaban Bay, is in fact on the continent, as represented by the native of Dawæ in the map under discussion. Antonio Roland, a Portuguese who had long frequented these parts, informed me, that a boat sailing with a fair wind requires twenty-four hours to reach the mouth of the Rangoun river from this island, which, allowing two marine leagues an hour, will give a distance of 144 geographical miles,—quite incompatible with the distance at which Martaban is laid down by Mr Arrowsmith from Rangoun. Bhalu Island, according to the Map of the native of Dawæ, is of considerable extent, and is high land, appearing as if a continuation of Zaingiaik hills ‡.

The country south from Martaban seems to be divided into valleys by several ridges of hills, running parallel to the sea: and the Government of Ye, besides the Island of Bhalu, occupies the space between the sea and the nearest ridge, which space is in general flat and productive of rice, and is watered by a small river running from north to south. The town called Ye or Je is said to be large, and to be built on a rock surrounded by a creek or perhaps ditch, the same term being used for both in the Mramma language. This Government of Ye is separated from Mouttama by a river called Asami, which rises from the central ridge that separates Siam from Pegu; and it formed a part of the ancient kingdom of the latter name. Its proper natives, therefore, were Talain or Moen; but most of these have retired to Siam, and are no doubt anxious to recover the land of their fathers. From Mouttama to Ye coasting boats take about two days, going from sunrise to four in the afternoon; but during the remainder of the day or in squalls, they retire into some of the creeks with which the coast abounds. From the map it would also appear to be sheltered by more shoals and islands or rocks than are laid down in our charts.

---

* See this *Journal*, No. IX. p. 82.

† No. IX. p. 83.

‡ No. IX. p. 82.

Between the ridge of hills bounding the district of Ye on the east, and the great central ridge of the Malay peninsula, there seems to be a fine valley watered by a considerable river. This rises by two heads, of which the largest comes from the central ridge, and is called Mrenibra, Pra or Bra, signifying the source of a river. The other branch springs from the highest part of the western ridge, forming a mountain called Wænpo, which communicates its name to the stream issuing from it. The united streams form the river of Dawæ or Tavay of European geographers, and boats navigate this to the junction of the two branches by which it is formed. A little way below this junction, on the east side of the river, is a city named Kaleinaun, the capital of a small government which formerly belonged to the kingdom of Pegu, and occupies the upper part of the valley watered by the river of Tavay. Towards the north, this valley, with all the vicinity of the ridge of hills separating the kingdom of Pegu from that of Siam, is occupied by very extensive woods, which in some measure protect three rude tribes from the tyranny of both states. By the natives of Tavay these tribes are called Kadhu, Lowa, and Kuwi. The first of these are considered as a kind of Karæn, and are probably the same with the Karæn mentioned * as bordering on the east side of the Talain country. The Lowas, according to the natives of Dawæ, speak a kind of Siammese, which confirms the opinion already mentioned †, of the Siammese being descended from the Lowas, intermixed with colonists from China and India. With regard to the Kuwi, I heard only a report from some natives of Dawæ at Rangoun; but towards the frontier of Martaban there is a city of this name belonging to the Siammese, which I suspect is the *Couil* of M. Loubere. I have, however, learned nothing to enable me to judge whether this city derives its name from being inhabited by Kuwi, or merely from its being the mart for carrying on trade between the Kuwi and Siammese: one or other circumstance, however, is probably the origin of the name.

Although the tide reaches to the junction of the two streams which unite to form the river of Tavay, and although, of course,

* See this *Journal*, No. iv. p. 267. † No. iv. p. 268.

boats can ascend the whole way, yet at low water the stream is shallow, and vessels of any burthen must anchor at the mouth of the river. From Martaban this anchorage is about four or five days' sail for boats coasting, as I have already mentioned, that is, sailing about ten hours a day. The distance, according to Arrowsmith, is about sixty-four marine leagues, or sixteen leagues a-day; for much time is lost in going in and out of creeks for shelter, and in going round shoals, rocks and headlands, with which the coast abounds. From the anchorage to the city of Tavay, boats go up with one tide; the distance, therefore, is probably less than Mr Arrowsmith has adopted. Another tide carries boats up to Kalinaun, which, therefore, is not probably more than forty or fifty miles from the mouth of the river. When Tavay belonged to Siam, it was built of brick, and was a large place: but now it is reduced to buildings of wood and bamboo, those of brick, by the law of Ava, being reserved for God and the King, or for such favourites as may obtain special licence, and this is seldom indeed granted.

Dawæ stands on the east side of the river, between which and the sea is a very narrow ridge of land; for it is only three hours journey by land from Dawæ to Moycip, a village opposite to which there is a good anchorage, sheltered by islands, rocks, and sands. On the ridge between Tavay and Moycip, and not far from the road, is said to be a volcano; nor is this improbable, as the island of Narcondam, at about seventy leagues distance, has been long in a very active state of ignition.

A considerable quantity of tin is procured from the territory of Dawæ. The mines are on a large hill on the great central ridge, and called Sakana. It is four days' journey by land, south and east from the city of Dawæ. The tin found there is reckoned very fine, and is coined into a money current in that vicinity. It is to be observed, that tin-mines are also situated in Junk Ceylon, as it is called in our charts, to the south, and near Taunu to the north; and there is reason to think, that, throughout at least the whole of this length, the ridge of hills passing on the east side of Dawæ is continued, which would perhaps imply a continuity of mineral productions, extending from Lat. 7° 30′ to Lat. 19° N., or about 800 miles.

Besides tin, the district of Tavay produces black pepper and cardamoms for exportation. Both are very inferior in quality to those produced in Malabar; and the cardamoms, I presume, are of the kind described by Rumphius, which is a different plant from that cultivated in Malabar.

The territory under the Governor of Dawæ reaches the whole way from the sea to the frontier of Siam, including both the lower part of the valley, in which Kalinaun is situated, and the coast south from Ye.

It reaches along the coast a little farther south than the Tavay Island of our seamen, which by the natives is called Maleille-kiun, that is about 12° 40′ N. latitude; and on the north to near Ye, which, being half way between Tavay Point and Martaban, will be nearly in 15° 20′ N.; so that from north to south the district will extend about 140 geographical miles. The river Tavay, I should imagine, is not near so considerable as Mr Arrowsmith represents. From the mouth to the forks, where it is formed by two rivulets descending from the hills, he makes about 130 miles; but boats go this distance in two tides, which I do not think will allow more than forty miles in a direct line; and Taway should be about half of this distance from the anchorage. At no great distance from the anchorage, between it and the central ridge, towards a great hill named Kiappuctaun, is a ruined city called Taumboup, once a place of some consequence.

The Southern Government occupied by the tribe of Tanaensari takes its name from the capital city, called Breit by its inhabitants, and Mergui by Europeans. This government extends along the coast from about 12° 40′ north to a village named Mazé, which is nearly half way between Mergui and Junk Ceylon, that is, about 10° N. latitude, giving thus 2° 40′ or 160 geographical miles for the length of the district. Its breadth, like that of Tavay, is not nearly so considerable, being confined between the sea and the central ridge of the peninsula, which in the 10° of latitude, is only about 80 miles across, and at Mergui is only about 120. The width of the province, therefore, may be from forty to sixty geographical miles; but it besides includes a great many islands, composing the Mergui Archipelago of European navigators.

Among those islands is found ambergrease, and they produce some of the finest swallows' nests that are sent to the Chinese market, together with much biche-de-mer. This is a very large marine slug, nearly allied to the genus Onchidium, and when dried and smoked, notwithstanding a most forbidding appearance, is in great request among the luxurious Chinese, as a stimulating article of food. It seems different from any of the species mentioned by Cuvier *, and has not, so far as I know, been described by naturalists. Along this coast, and on the adjacent islands, is prepared a great quantity of shrimps and prawns, which are dried in the sun, and formed into a mass called *Ngapi* by the Burmas, and *Balachong* by the Indian Portuguese. Much balachong is also prepared from fish; but this is not so much valued as that prepared from crustaceous animals. This substance is highly offensive to the smell of Europeans, and equally so to sight; but among all the nations east from Bengal, and in the great Indian Archipelago, it is the grand seasoning for rice, and in universal demand. Besides grain, the vegetable productions of this territory that are fitted for exportation, are cardamoms, black-pepper, and betlenut. It has no mines.

Breit or Mergui, the chief town of this province, stands on an island situated in the mouth of a considerable river; but which, I suspect, is not near so large as represented by Mr Arrowsmith. In this map it is represented as passing through the great ridge that bounds this province on the east, and of course rising in the dominions of Siam. It comes by two sources from the eastern face of the central ridge, and the most remote issues from a high peak called Kiæppue-taun, or Cock-fight Hill, which is nearly east from the mouth of the Dawæ river, about 100 geographical miles north from Mergui. The shorter branch springs from the vicinity of Sakana, where the tin-mines of Dawæ are, four days' journey SE. from that city. On ascending this river three or four days, boats come, on the northern side, to the ruins of the ancient capital, named Tanænsari by the natives, and Tenasserim by Europeans. This is nearly east of Mergui, and was formerly the residence of the princes who

* *Regne Animal*, vol. ii. p. 410.

governed both districts, never perhaps as independent princes, but certainly at least as hereditary tributaries.

In going by land from Tanænsari to Piappi, a town on the Gulph of Siam, the traveller crosses many streams all running towards that sea, which would seem to imply, if the two branches of the Mergui river spring from the east side of the central ridge, that immediately beyond Tanænsari there is another ridge, on the farther side of which the route between this city and Piappi lies, while the upper part of the Mergui river is confined in the valley between the two ridges.

From about Lat. 10° N. to the frontier of the Malay state called Queda, the western coast of the peninsula formed a government fully subject to Siam, and governed by an officer called by the Siammese Bhura Silan or Lord of Silan, because his principal residence was on the island of Junk Ceylon of our mariners, which Mr Arrowsmith calls Salanga Island. This governor was not a hereditary prince like the King of Queda, but held his office at the pleasure of the Siammese monarch. The town where he resided was at the SE. end of the island, some way up a river. Captain Thomas, who commanded the Seahorse, in which I went to Rangoun, visited the place, where he was politely received, and traded with the governor for tin, on account of the King of Siam. The mines are on the island, and are under the management of Chinese. On the continent, opposite to the NE. end of the island, is a large town called Papara, from which the strait separating the island from the main derives its name. The Mranmas, I believe, call this island Salæmo, and say, that from thence boats can go to Piappi, a town on the Gulph of Siam, in six or seven days. If there be not some mistake in this, there must be a passage from the Bay of Bengal to the Gulph of Siam, leading from the Straits of Papara, and thus rendering Malaya an island, and not a peninsula. Such indeed at Ava I always heard alleged to be the case; but as the accounts I received were contradictory, and in general placed the passage at or near Mergui, which was entirely denied by the natives of that place, I should have abandoned all ideas of such a passage, were it not from the report given concerning Salæmo by the natives of Mergui; not that I look upon this as sufficiently conclusive, but still it de-

serves some attention. Although the passage is said to have salt-water all the way, it seems to be navigable only for boats or small vessels.

Towards the frontier of the Mranma territories, on the Bay of Bengal, in 1795, the Siammese had a large town named Særæn, in the vicinity of which many elephants are caught. It was in the government of the Bhura Silan, as is also Bangarim, a town between it and Papara. This government was subdued by the Burmas in 1810, but has probably been since restored to Siam.

Queda on the west, and Tringani on the east side of the peninsula, adjoin to the Siammese dominions, I presume at the channel crossing from the Straits of Papara to the Gulph of Siam, if such exist. Both are inhabited by Malays of the Mahommedan religion, and governed by hereditary chiefs, who assume the title of Sultan; but whenever the Government of Siam is in vigour, they pay tribute to its King (Poa of Duarawadi), who allows them the title of Raja.

Art. V.—*On the Knight's Moves over the Chess-board.*

Having in a former Number (Vol. IV. p. 393.) given a copious abstract of an ingenious and successful attempt to analyse the Automaton Chess-player of M. de Kempelen, which has so long excited public attention, we return to the curious but anonymous work which furnished us with that abstract, for the purpose of giving an account of the various methods by which the chess-board may be covered by the moves of the Knignt.

This curious operation was often exhibited by the Automaton, both over the whole board, and over half of it; and the ingenious author of the work alluded to, was thus led to study the subject, and to determine that this operation might be performed on any parallelogram consisting of *Twelve* squares and upwards, with the exception of *Fifteen* and *Eighteen* squares. Two of these operations we have already given in the volume already referred to; and we shall therefore confine ourselves to the collection of different solutions made by our author, and to those which he has himself discovered.

The path of the Knight over the board is of two kinds, *terminable* and *interminable.* It is *interminable*, whenever the last or concluding move of a series is made in a square which lies within the Knight's reach of that from which he originally set out; and *terminable* in every other instance.

The celebrated Euler published a paper on this subject in the Memoirs of the Academy of Berlin for 1759, and has there given a method of filling up all the squares, setting out from one of the corners. He has likewise given an endless or interminable route, and he explains a principle by which the routes may be varied so as to end upon any square. Solutions of the same problem have also been given by Montmort, Demoivre, and Mairan, which are given in Plate VI. in the following order:

Terminable Routes over the whole Board.

No. 1.	By Euler.	No. 6.	By Demoivre.
2.	Ditto.	7.	Mairan.
3.	Ditto.	8.	Montmort.
4.	Ditto.	9.	the Author.
5.	Demoivre.	10.	the Author.

Interminable Routes over the whole Board.

No. 11.	By Euler.	No. 16.	The Author.
12.	Monsieur W	17.	Ditto.
13.	the Author.	18.	Ditto.
14.	Ditto.	19.	Ditto.
15.	Ditto.	20.	Ditto.

ART. VI.—*Remarks on the Phenomena of the Fall of the Leaf, and the Physiology of the painted Corolla of the Flower.* By JOHN MURRAY, F. L. S. M. W. S. &c.

THE phenomenon of the fall of the leaf in autumn has been variously accounted for. The learned and eloquent President of the Linnean Society has presumed it dependent on the maturation and expansion or swell of the bud, and this opinion has been adopted by others. M. Vaucher ingeniously compromises the question by considering the leaf *soldered* or cemented to the twig. This latter hypothesis is soon discussed. The most careless observer can discover the continuity of the vessels,

The experiment is a very simple one. Let a leaf be torn from the twig, and a portion of bark and wood follows. When the leaf assumes the autumnal tint, then indeed, as with the ash, &c. it *may be* insulated, but the leaf is now *dead*, the vessels of supply no longer minister their living juices,—its veins are exhausted, and it hangs a withered appendage, and prey to the first autumnal breeze.

There are, in like manner, circumstances which do not harmonize with the first opinion: but to mention the fall of the early blossom in an analogous relation, the sudden denudation of the mulberry-tree, without any change of colour, by early frost *, shews us that the cause may act *suddenly* and *prematurely*, and must be *something distinct from the dimensional increase of the bud.*

The sap has its periodical revolution, and as it moves in its channel, acted on and influenced by the vicissitudes of an atmosphere ever varying its *density*, and the *thermometric*, *hygrometric*, and *electrical* relations of which are always fluctuating, it must change its pulse conformably; and the flux of its stream must correspond with the circumstances on which it hinges, and by which it is accelerated or retarded, regulated or checked.

The spring gives an animating stimulus to the *punctum saliens* of vegetation, which is thus aroused from its *hybernaculum*, and the tree then assumes its beauteous and refreshing mantle of green. This is succeeded, as the season advances, by the blossom and the fruit.

Now, the sap must not only be much varied in its periodic times of revolution, but be obedient to the external agents enumerated, and thus will the character of its deposits be essentially changed. The sap, at first rapid, becomes, as the sun advances toward the tropic of Capricorn, more languid in its course. The tints of autumnal foliage are the external insignia which announce the changes that take place. The gradual disunion and final fall of the leaf, is connected with the gradual contraction and close of the anastomosing vessels, and this constriction is the consequence of a loss of caloric, by reason of *radiation* to the unclouded sky; or, in the absence of the illuminating sunbeam, in dark weather. All circumstances being the same,

* See Bradley on Gardening, Lond. vol. i, p. 194, and vol. ii. p. 51.

the amount of denudation will have a faithful correspondence with the phenomena which favour radiation; and I am persuaded, from repeated observation, that the leaves which strew the brooks are more numerous in the evening and at night than during day, when the calorific impressions of the sunbeam play on the leafy surface.

There is a phenomenon which I do not remember to have seen any where estimated, though it seems to me to add force to the opinion presumed. In the *beech* and *oak*, &c. particularly in the former, the leaves begin to fall from the *tips* of the twigs or branches, and are shed *gradually downward:* now this is in exact conformity with what should happen in consequence of radiation; the lower foliage is protected from its effects by that above it, the last, being lowered in temperature, falls, and exposes that leafage which before was comparatively concealed and sheltered; it falls in turn, and is succeeded by the next, &c. We cannot suppose this phenomenon connected with the gradual retirement of the sap from the extremities of the branches. The twig can never be wholly exhausted of sap;—the circulation is comparatively languid, and its action torpid; but were it to evacuate the branch entirely, it must cease to live. In torpid animals the circulation continues, though reduced to its lowest ebb. Experiment has determined this, and the analogy holds good.

In spring, the temperature acquired by absorption *more* than counterbalances the loss sustained by *radiation*, while in autumn this last is a *maximum*. In very early spring, the premature blossom is often cut off by the sudden contraction of the vessels which supply it.

By watering the early bloom before sunrise, the fatal consequence referred to is perhaps prevented; because the effects of radiation are modified by a film of aqueous vapour; or the previously contracted vessels are softened and expanded to the more gradual reception of the temperature shed upon the flower by the solar ray.

The COROLLA is a very interesting subject of inquiry. The celebrated Linnæus conceived that the petals acted as wings to waft the flower up and down in the air. Others have believed

that the radiant disc reflected heat into the interior of the flower; and the author of the "Botanic Garden" considered the petals as the lungs of the blossom.

We witness the flower of the plant unfolding its blossom to welcome the orient beam, and when the shadows of the evening close around it, we see it fold up its drapery, and droop and decline. The *Helianthus* seems to trace with its radiant corolla the march of the sun; and we see the *daisy* open its golden eye to the solar ray. It is clear, then, that there is a relation between the disc of the flower and the sunbeam.

The *coloured* petals appear to drink deep at the solar fount, and to maintain a temperature in correspondence with their tints and relation to the prismatic colours. Consequently, the flowers indigenous to an "*ultima Thule*," will preserve that temperature inviolate, "amid an atmosphere with ice still lingering in its veins," while those plants which bear the same beauteous tapestry, and glow in more brilliant and richer dyes, under a vertical and burning sun, will absorb no more. When the sun is concealed, then those flowers will radiate temperature, and be completely shut, so soon as it amounts to that of the ambient medium.

The colours peculiar to arctic and antarctic regions, as well as those which decorate alpine scenery, considered relatively with those which adorn the plants of equatorial climes,—nay, even the early flowers which beautify our spring, will be found in the utmost harmony with this view. The *snowdrop* first appears on the scene, not even daring to lift its eye to a cold and watery sun,—the external white of the corolla, the *worst* radiator, will reflect none of that which the golden cup within has imbibed from the illuminated medium;—while the *autumnal crocus* has its blue insignia in accord with the declining sun; and as it emerges from the earth, the bud is *white*, because otherwise, as it could have received nothing from light, so it could lose nothing by radiation, without certain injury.

So soon as the solar ray strikes the crimson tips of the *daisy* (*i. e.* the "eye of day"), it begins to unfold its bloom to the influential temperature of the sunbeam, and it shuts up its snowy corolla in the evening, to protect the acquired warmth of the day from further reduction.

Thus does it expand the blossom in virtue of the absorption of *heat* * from the sunbeam, and as it loses part of its acquired temperature by radiation toward the afternoon and evening, it will slowly close by the contraction of the fibres, the necessary consequence of decreased temperature. There may be instances which seem counter to this deduction, such as the "*night-blowing cereus*," the "*marvel of Peru*," &c. These plants, however, are not indigenous to Britain. The loss sustained by radiation on the part of the corolla, will reach its *zero*, when it amounts to that of the ambient air. The flower has now locked up its petals, and lower it cannot fall, though the temperature of the ambient air may continue to decline.

The *Nymphæa*, and its congener the *sacred Lotus* of the Ganges and the Nile, gradually shut their flowers as the evening advances, and finally plunge beneath the wave,—a medium of uniform temperature, and where loss by radiation is unknown.

I wish it to be distinctly understood, that I have been led to the opinion now presumed, in virtue of a very extensive series of *experiments* (*many hundreds*), on the temperature of the coloured corolla at different periods of the day, &c. To detail these would occupy some pages; but an example may be given. The ball of a delicate thermometer was, in such cases, either placed on the expanded polypetalous disc, or introduced into the monopetalous bell, tube, &c.

On the shelf of a greenhouse stage, *Calla Æthiopica*, 55° Fahr.; *Rosa odora*, 56° Fahr.; *Amaryllis Johnsoniana*, 57° Fahr.: out of doors, air, 54.5, *Corchorus Japonica*, 56°; double red *Anemone*, 57.5° Fahr. Air, 62° Fahr.; *Bellis perennis*, 61° 5'. In another experiment, air, 63° Fahr., *Carduus*, 64.5; *Campanula*, 64°. And, *Air*, 58° Fahr. *Centaurea montana*, 59°; *Leontodon Taraxacum*, 60.5° †.

* Many an anxious visit to the *Cactus grandiflorus* has been disappointed; but the Curator of the Botanic Garden at Hull informs me, that the corolla *expands instantly*, and with a species of *elastic* force, on bringing a *choffer of ignited coals near it*.

† So have I found a gradually declining temperature in flowers toward evening; the *red* coloured corolla being lower than the *yellow*, the *blue* still less, and the *white* not sensibly varied.

ART. VII.—*Notice in regard to the Temperature of Mines.* By MATHEW MILLER, Esq. 51st Light Infantry, M. W. S *.

THE late experiments on the temperature of mines made in Cornwall, and in other countries, having given rise to various speculations in regard to the distribution of heat in the crust of the earth, all of which appear to me to be unsatisfactory, I now beg leave to offer for consideration of the Society, an explanation, which does not seem liable to the objections that have been opposed to the others.

In every mine, with the exception of a few, which are level-free, the ventilation is carried on by causing the air at the surface to descend, and traverse the works, and then ascend. Now, it is evident, that if a portion of air from the surface be carried down to the bottom of the mine, it will be condensed in proportion to the depth of the mine, and, in consequence of this condensation, will become heated, and the degree of heat will of course be in proportion to the depth of the mine. The air thus heated traverses the works, and imparts its heat to the strata; it then ascends, and is succeeded by a fresh portion of air from the surface, which in the same way becomes heated, and imparts its heat to the strata, and they, in turn, communicate it all around. Thus, in a long course of working in a deep mine, the air at the bottom is heated, and also the rocks to a considerable depth; and when the working ceases, the mine takes a long time to lose its temperature; and this is found to be the case, particularly when the mine becomes full of water, the water being found at first of a high temperature, and gradually to lose its heat, which is in consequence of the strata imparting theirs to the water, and as soon as they have given out all their heat, the water indicates the mean temperature nearly of the place.

The reverse takes place in an old mine when reworked; in that case, the temperature rises gradually as the working continues: and in those mines which are not worked, but in which

---

* Extracted from the *Memoirs of the Wernerian Natural History Society*, vol. iv. Part 2.

the ventilation still goes on, I believe it will be found that they do not lose more of their temperature than can be placed to the abstraction of the other causes of heat in working mines, such as that produced by the men, and the lights.

The exact quantity of heat given out by air, in proportion to its condensation, it is difficult to ascertain, but every day's experience proves it to be very considerable; and, I believe, this, added to the other obvious sources of heat in mines in a state of working, will be found sufficient to account for their high temperature.

Art. VIII.—*Tables of the Variation of the Magnetic Needle in different parts of the Globe.*

The interest which has been recently excited by the great discoveries in electro-magnetism, and the probability that the meteorological and magnetical phenomena of our globe have some strong bond of connexion, render it desirable that the various observations on the Variation and Dip of the Needle should be collected together. Professor Hansteen of Christiania, from whose interesting work on the Magnetism of the Earth we have already made copious extracts * (the only ones, indeed, that have yet appeared in our language), has collected almost all the observations that have been made up to the year 1818, when his work was completed.

We shall therefore translate his Tables, so far as they go, and then add all those observations which have been made during the last six years. We have omitted the names of the observers as unnecessary, and also the longitudes and latitudes of the places of observation, as every person can readily obtain this information from ordinary works, and as the insertion of them at present would swell the Tables to a length that would have rendered them quite unfit for the pages of a periodical work.

---

* See this *Journal*, Vol. III. p. 124.; Vol. IV. p. 111. and 363.

Table I. *Containing the Variation of the Needle, as observed in Denmark, Norway and Sweden.*

Names of Places.	Year of Observation.	Magnetic Variation.	Names of Places.	Year of Observation.	Magnetic Variation
Arendal,	1796	20° 21′ W.	Copenhagen	1774	16° 27′ W.
Arboga,	1799	17 25		1775	16 37
Avestad,	1799	17 40		1775	16 20
Bergen,	1768	19 20		1775	16 33
	1791	24 45		1775	16 26
	1792	25 30		1775	16 27
Bommel Island,	1792	24 52		1776	16 27
Bessested,	1780	34 30		1776	16 30
Christiansund,	1768	16 30		1776	16 30
Christiansand,	1794	22 0		1776	16 28
Christiania,	1761	15 15		1776	16 32
	1769	16 45		1777	16 20
	1816	20 15		1777	16 39
	1817	20 3		1779	17 5
Carlberg,	1799	17 5		1782	17 41
Carlscrona	1716	11 15		1783	17 49
Copenhagen	1649	1 30 E.		1784	17 42
	1672	3 35 W.		1784	18 0
	1730	10 37		1785	18 7
	1731	11 15		1786	18 9
	1765	15 5		1792	18 23
	1765	15 3		1793	18 15
	1767	15 7		1806	18 25
	1768	15 13		1807	18 21
	1768	15 0		1808	18 22
	1768	15 2		1809	18 22
	1768	14 50		1810	18 16
	1768	14 56		1812	18 17
	1769	15 30		1813	18 22
	1769	15 29		1813	18 11
	1769	15 34		1813	18 10
	1769	15 22		1813	18 14
	1770	15 32		1813	18 8
	1770	15 32		1814	17 58½
	1770	15 32		1814	17 56
	1770	15 32		1814	17 56
	1770	15 37		1815	18 6
	1771	15 32		1815	18 3
	1771	15 42		1815	18 5½
	1771	16 2		1816	18 15
	1772	16 17		1817	18 5
	1772	16 0		1817	17 55½
	1773	16 12	Drontheim,	1761	13 50
	1773	16 16		1769	15 25
		16 17		1770	15 30
	1773	16 22		1771	15 40
	1773	16 9		1772	16 6
	1773	16 20		1773	16 40
	1774	16 17		1774	16 46
	1774	16 20		1775	16 58
	1774	16 32		1776	17 30

TAB. II.—*Continued.*

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Drontheim,	1777	17°45′W.
	1778	17 50
	1779	18 0
	1780	18 0
	1781	18 24
	1782	18 30
	1783	18 32
	1783	18 30
	1784	18 35
	1786	19 0
Dyrefiords Haven,	1786	42 41
Fahlun,	1799	18 15
Flekkeröe,	1783	19 29
Fredericksborg,	1810	18 50
Gottenburg,	1694	8 30
	1748	12 40
Havnefiord,	1786	35 21
Holmenshavn,	1786	43 9
Hammerfest,	1765	6 50
Hustappen Island,	1766	7 0
Hvalöers Church,	1768	16 25
Hveen Island,	1672	2 35
Helsingöer,	1761	14 0
Hedmora,	1748	9 10
Jukasjerwi,	1776	11 30
Kielvigs Church,	1766	5 30
Karasjok,	1768	6 50
Kongswinger,	1779	17 30
Kullens,	1803	21 0
Köping,	1799	17 15
Nya Kopparberget,	1799	17 25
Kongsör,	1746	9 30
Kusamo Church,	1776	5 30
Lindesness,	1605	7 10 E.
Lofoeden Isles,	1608	0 0
	1609	0 0
Lund Pfarrhof,	1785	19 30 W.
Lyderhorn,	1768	19 20
Lindesberg,	1746	9 36
North Cape,	1769	6 0
Nora,	1799	18 35
Norrberke,	1799	17 35
Orebroe,	1799	17 7
Patrixfiord,	1772	33 30
Rust Island,	1613	4 8 E.
Stavanger,	1794	22 26 W.
Skudesness,	1613	8 0 E.
Stadthuk,	1768	19 10 W.
	1790	25 45

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Stockholm,	1718	5°37′W.
	1763	11 48
	1764	11 58
	1765	12 8
	1766	12 15
	1767	12 21
	1768	12 28
	1769	12 33
	1771	13 4
	1772	13 4
	1775	13 20
	1777	13 56
	1786	15 34
	1787	15 17
	1800	16 20
	1811	15 52
	1817	15 36
	1817	15 31
Salberg,	1716	9 0
Sala,	1799	16 0
Soderbärke,	1746	9 15
Sälö Bäk,	1804	18 30
Sädankyla,	1776	5 30
Skiervoens Church,	1768	16 30
Strömstad,	1804	18 0
Sulen Island,	1791	27 15
Talvig,	1766	6 50
Torneå,	1695	7 0
	1736	5 5
	1748	7 30
	1767	8 50
	1777	11 45
Utsjoki,	1718	3 30
Upsal,	1718	5 37
	1740	8 19
	1746	8 45
Uhma Capel,	1762	10 45
Uramenburg,	1672	2 35
Wardhus,	1748	0 0
		0 30
	1775	5 32
Vadsöe,	1748	0 30
		1 0
	1816	7 55
Vangs Church,	1793	19 50
Vesteräs,	1799	17 50
Vinga Bäk,	1804	19 0

Table II. *Containing the Variation of the Needle in Russia.*

Names of Places.	Year of Observation.	Magnetic Variation.
Awatscha Bay,	1805	5° 39′ E.
Barrannoi Kamen,	1787	17 10
Barnaul, -	1770	2 45
Casan, -	1761	2 25 W.
	1805	2 2 E.
Catharinenburg,	1761	0 50
	1805	5 27
Carchow, -	1783	7 27 W.
	1811	5 17
Cherson, -	1782	10 10
Caffa, -	1772	7 0
Dmitrewsk,	1771	5 49
	1773	6 30
Druia, -	1773	10 10
St Elizabeth,	1770	9 45
Gluchow, -	1770	5 30
Gurief, -	1769	3 25
Gloubouca, -	1615	18 0
Jakutskoi, -	1768	5 15
	1769	5 0
	1788	2 0
Irkutsk, -	1735	1 15
	1735	1 19
	1805	0 32 E.
Jarowslawl, -	1782	4 0 W.
Jenicola, -	1785	7 15
Kola, -	1769	2 15
	1769	1 15
	1769	1 45
	1769	1 45
Krementschuk,	5770	8 0
Krasnojarsk,	1735	2 0
	1735	1 0
	1735	1 45
	1735	1 30
Kiachta, -	1735	3 0
	1735	2 45
Kiow, -	1773	9 15
Kaluga, -	1784	7 45
Kursk, -	1784	5 0
Kostroma, -	1782	3 45
Kesloff or Kozlov, -	1785	11 38
Lubny, -	1782	9 5
Moscow, -	1732	5 26
Mosdok, -	1785	6 40
Nezshni Kovima,	1787	14 40 E.
Nizni-Udinsk,	1735	3 15 W.
	1805	2 10 E.
Nertschinsk,	1735	3 0 W.
Neschin, -	1779	10° 0′ W.
	1782	10 0
Orenburg, -	1769	3 30
		3 20
Orsk, -	1769	0 15
Orel, - -	1781	9 0
Petersburg,	1726	3 15
	1727	2 30
	1730	4 4
	1741	3 56
	1755	4 30
	1772	3 30
	1774	4 50
	1782	7 30
	1784	8 13
	1797	9 12
	1805	11 0?
	1806	7 52
	1811	7 36
	1812	7 16
Perm, -	1805	1 10 E.
Petropaulowska,	1779	6 19
	1805	5 20
Petrosawodsk,	1785	5 9 W.
Ponoi, -	1769	1 10 E.
Peczora, -	1611	22 30 W.
Pustozerskoi,	1614	20 0
Revel, -	1751	7 30
Riga, -	1750	8 0
Samara, -	1770	8 10
Sietscha, -	1770	9 15
Sisrau, -	1770	5 50
Selenginsk,	1735	0 0
	1735	0 30
	1735	2 45
Saratow, -	1773	3 28
Sewastropol, -	1785	11 13
Tscherkask, -	1770	5 50
Tara, -	1805	6 6 E.
Tomsk, -	1805	5 37
Tobolsk, -	1716	0 0
	1761	3 46
	1805	7 9
Tanbow, -	1784	5 45 W.
Umba, -	1769	3 30
Ufa, -	1769	1 30 E.
Ustkamenogorskoi,	1770	2 0
Wologda, -	1785	3 52 W.
Woronetz. -	1783	8 0
Zarizin, -	1770	4 50

TAB. III. *Containing the Variation of the Needle in Holland, Prussia, the Netherlands, and Switzerland.*

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Antwerp,	1600	9° 0′ E.
Amsterdam,	1767	17 30 W.
Augsburg,	1772	16 40
	1798	18 26
Berlin,	1717	10 42
	1717	10 52
	1724	11 45
	1725	11 56
	1725	11 52
	1751	14 16
	1764	14 15
	1770	16 9
	1773	16 18
	1774	16 54
	1775	17 1½
	1777	16 42
		16 45
	1777	16 42
	1778	16 45
	1779	16 16½
	1780	16 48
	1782	17 47
	1783	17 51
	1784	17 57
	1785	18 3
	1786	18 20
	1787	17 41
	1788	17 5
	1805	18 5
	1805	17 57
	1805	18 2
Bonne,	1782	17 20
	1784	17 41
	1787	18 1
	1788	18 55
Dantzic,	1628	1 0
	1642	3 15
	1670	7 20
	1682	8 48
	1760	11 0
	1811	13 48
Dusseldorf,	1783	20 0
Dresden,	1797	18 30
Freyberg,	1769	15 40
Frankfort-on-Mayne,	1774	16 32
Franeker,	1771	19 30
	1773	18 30
Geneva,	1797	19 40
	1800	21 30
Geneva,	1801	21° 26′ W.
	1802	21 27
	1803	21 18
	1804	21 13
Grätz,	1770	15 50
Göttingen,	1777	16 48
Hague,	1782	20 16
Inspruck,	1787	22 40 ?
Konigsberg,	1600	0 0
	1628	1 0
	1642	1 5
	1774	13 30
Leipsic,	1749	13 0
Manheim,	1776	19 18
	1785	19 44
	1786	19 53
	1787	20 2
	1788	20 5
Mittau,	1783	10 52
Middleburg,	1786	21 14
	1788	21 56
Nuremberg,	1685	5 5
Prague,	1774	15 45
	1775	16 15
	1781	16 50
	1782	17 44
	1786	18 9
	1787	17 20
Rotterdam,	1767	19 0
Regensburg,	1784	17 49
	1785	19 1
	1786	19 11
Tübingen,	1747	13 34
	1748	14 22
	1749	14 45
	1750	14 30
	1752	14 37
Tankermund,	1814	19 0
Vienna,	1638	0 0
	1760	13 0
Wurtzburg,	1781	18 40
	1782	18 40
	1783	18 39
	1784	18 30
	1785	18 33
	1786	18 31
	1787	18 35
Zurich,	1762	15 15

(To be Continued.)

Art. IX.—*Gleanings of Natural History, gathered on the Coast of Scotland during a voyage in* 1821. By the Rev John Fleming, D.D., F.R.S.E., M.W.S. &c. (Continued from Vol. VIII. p. 303.)

IN the forenoon of the 6th August we again touched at Thurso. In the store-house belonging to the salmon-fishery on the east side of the river, we observed a large Pollack, or, as it is called on the west coast, where it abounds, *Lythe*. On the east coast it is seldom met with, although at the Isle of May we have caught them with a rod in company with the young of the cod and coal-fish. Leaving Thurso Bay, our course was now directed westward, for the purpose of passing through the Pentland Frith. While abreast of the Whitenhead it was easy to discover, from the change which had taken place in the shape of the cliffs, and their manner of decomposition, that we had passed the limits of the great deposit of sandstone which occurs on the east and north of Caithness, and of which the islands of Orkney chiefly consist.

The *Salpa moniliformis* of Dr MacCulloch, who first described and figured the animal, was observed in the evening in great abundance. When young, the condition in which they were at this time, the individuals adhere laterally in such a manner as to form chains often of a foot or more in length. Eight days after this they appeared in general detached, having attained their full size, in which they exceed an inch. At each extremity of the back there is a conical process; nearly equal to the body in length. The anteal process which covers the branchial orifice, is more produced than the other; which last exhibited some appearances of a vascular structure. The stomach was *of a dark brownish orange*, and (as well as the branchial band) was distinctly seen through the transparent gelatinous body. This species, (which is probably the Salpa maxima of Forskael, *Descriptiones Animalium*, p. 112.), is very abundant in company with our *Eulimæna quadrangularis* in the friths among the Hebrides. It is to be hoped that the attention of the naturalists of those districts will be directed to the investigation of its history, at present very obscure.

When at the mouth of Loch Eribol on the morning of the 7th, we landed at the cave of Uamh Smowe, which has been so well described, (we believe by one of the greatest writers of the age), in the Edinburgh Annual Register for 1812, vol. v. p. 2. p. 438. It is situated in a horizontal bed of bluish compact limestone of great extent, abounding in beds and contemporaneous veins of white quartz. Upon entering the cave numerous *wild pigeons*, *water ouzels* and *common sandpipers*, (Totanus hypoleucos), hastily escaped. The walls were hung with *Scolopendrium vulgare*, *Cyathea dentata*, *Rhodiola rosea*, and *Chrysosplenium oppositifolium*. On the mossy ground over the roof of the cave, especially near the place where the rivulet enters it through a chasm in the rock, the *Dryas octopetala* was flowering in a healthy state, probably the northern limits of its British geographical distribution. In walking from the cave to a sandy bay on the east side of Tarout-head, the *Saxifraga aizoides*, *Thalictrum minus*, *Habenaria viridis*, *Listera ovata* and *cordata*, invited our attention. A few shells were likewise observed, viz. *Helix nemoralis* and *Arbustorum*, *Bulimus fasciatus* and *Vitrina pellucida*. On the beach we observed many fragments of *Spongia palmata*, and in the deeper pools left by the tide the *Aplysia depilans* seemed to abound.

In the morning of the 8th we found ourselves to the westward of Cape Wrath. Nor did we find this promontory misnamed, for we soon experienced a stiff gale, which induced us to take shelter in Stornaway. Next morning, in expectation that the wind would abate, we proceeded on our voyage, but were now forced to run into Loch Shell. The gneiss rocks which prevail at these two places exhibit little to interest the mineralogist on a cursory view. At the latter place we observed, in a fishing boat, many *Sea Bream*, here termed Braize. (The Cyprinus rutilus is called *Braize* in the river district of the Clyde.) This is the Pagrus Rondeletii of Willoughby, although the peculiar character which he assigns, "in pinnis dorsi et ani extremis cutis in sinum quendam procurrit, et extremos pinnæ radios obvolvit et fere occultat," (Ich. 312.), did not appear obvious. The *Hake* is, according to the testimony of the fishermen, frequently caught here; the *Tusk* occasionally. The former is probably near the northern, the latter near the south-

ern limits of their British geographical distribution. The *Escara cervicornis* is common on the fishing grounds in about seventy fathoms.

Leaving Loch Shell, we came to anchor in the south bay of Scalpa or Glass Island, on the morning of the 10th. In traversing the damp mossy surface of this island, which is intersected by numerous small lakes, the following plants occurred in plenty. *Schænus nigricans* and *albus*, *Drozera rotundifolia* and *Anglica*, *Nymphæa alba*, and *Lobelia Dortmanna*.

Upon visiting Tarbert, and returning by Urga, we had an opportunity of witnessing some interesting examples of the industry of the small farmers of Lewis. The surface of the ground is unusually rugged and naked. The inhabitants, however, collect the soil from those places where it is too thin, or even from the crevices of the rocks, sometimes in handfuls; and, by placing it on the more level spaces, make artificial fields, some of them not exceeding a square yard, in which they raise a scanty supply of winter-food for their cattle, which in summer enjoy an extensive range of hill-pasture. By the sale of their cattle and the produce of their fisheries, they contrive to live comfortably, and even to pay a considerable rent (on an average stated to us at L. 3 each farmer) to the proprietor, where neither residence, comfort, nor rent, on a cursory view, would be considered practicable.

In the forenoon of the 13th, we rowed round the west and north sides of Scalpa. The state of the tide permitted me to perceive the riches of the submerged rocks along the shore, covered as they were with a great variety of molluscous animals and zoophytes. Want of time, however, and a considerable swell in the sea, permitted only a casual glance. *Trochus ziziphinus*, *Echinus esculentus*, and *Alcyonium digitatum*, appeared to be common. By the examination of one of the Echini, while alive in a glass of water, and afterwards of fragments of the crust preserved in spirits, I was able to satisfy myself that the three species constituting the genus *Pedicellaria* of Müller, (Zool. Dan. i. p. 16. tab. xvi. f. 1–15.), are merely external organs of the Echinus, in which light Munro (on Fishes, Tab. xliv.), and Cordiner (Remarkable Ruins, No. xiii.) had previously considered them.

The specimens of *Alcyonium digitatum*, here procured, though all belonging to the same species, differed considerably in form and colour. By comparing them with the figures which Ellis has given in his Essay on Corallines, p. 83. tab. xxxii. a. A. A 2. and Phil. Trans. liii. p. 431. tab. xx. f. 10–13., no doubt remained in my mind with regard to the accuracy of the delineations which he has given, although doubts have been expressed by M. Lamouroux on the subject *. This naturalist having examined a species of Alcyonium, which he has described and figured in his "Polypiers Flexibiles," p. 336. tab. 12. f. 4. a. B. and tab. xiii, under the title *A. lobatum*, suffered himself to be misled in a way not uncommon, it is said, among his countrymen, by assuming similitude upon too slight grounds, and then confounding this similitude with identity. Hence he hastily concluded, that the *A. digitatum* of Ellis and the *A. exos* of Dr Spix (Annales du Museum, xiii. tab. 33.), belonged to his species. But the tentacula in his species are subcylindrical, rounded at the extremity, and covered above on the margin with blunt tubercles; the tentacula of the *A. digitatum* of Ellis are pointed and pinnated, while the tentacula in the *A. exos* of Spix, (the magnified appearance of one is exhibited, ib. fig. 7.), are subclavate, blunt, and villous. These remarkable disagreements of character between the figures of Ellis, and those of Spix, did not escape M. Lamouroux; but he accounts for them, (and the same reason we presume, he meant should apply to the want of resemblance between their figures and his own), by saying, "Cette différence est due peut-etre à *l'imperfection des instrumens* dont se sont servis ces auteurs,"—a charge brought, we believe, for the first time against Ellis, whose reputation for accuracy it cannot injure; nor can it be more destructive to the credit of the Bavarian naturalist.

In the course of conversation with the keeper of the lighthouse Mr Reid, a judicious observing man, I was informed that rats (the brown or Norway rat, which abounds in the Hebrides), after a shower, go down upon the rocks, while the limpets are

* In consequence of not employing sufficiently powerful lenses, Ellis and others have failed to observe the armature of diverging spiculæ at the summit of the ridges on the body at the external base of the tentacula.

crawling about, and, by a sudden push with their nose, detach them from the rock for food. Should the first effort fail, another is never attempted against the same individual, now warned, and adhering closely to the rock; but the rat proceeds instantly to others still off their guard, until enough of food has been procured.

On the 14th, we bore away for Loch Broom, but touched on the forenoon at the Shiant Isles. We landed on the north side of Gariveilan, near the mural promontory of columnar greenstone The rocks in this neighbourhood consist of slightly inclined and alternating strata of greenstone, trap-tuff of different kinds, highly calcareous, and containing *Belemnites* and flinty-slate, the characters of all of which have been minutely described by Dr MacCulloch in his "*Western Isles*," vol. i. p. 439. Guided by directions which I had received from Mr Neill, I soon met with the Wavellite, which he found here, and for the first time in Scotland, when making a similar voyage round the north of Scotland in 1811. Wavellite seems to be a recent production, as it forms a thin coating of cellular discs, not only on the surface of the flinty slate at the fissures, but on the surface of the detached masses which occur in these fissures. Towards the east side, in the high cliffs, we perceived indications of beds of iron-clay, and some dark-coloured stripes, which were probably beds of wood-coal. To the cliffs of these islands the more ordinary sea-fowl resort in great numbers to breed. The puffins were abundant.

We came to anchor in Loch Broom in the evening of the 15th, opposite to the village of Ullapool, an establishment once flourishing while the herrings frequented this part of the loch, but now quickly depopulating, since these fish have changed, in this neighbourhood, the route of their migrations. The village is built on a platform of stratified fresh-water gravel, considerably elevated above the present rise of the tides, and which must have been formed at a period when Loch Broom was a fresh-water lake, with its surface elevated considerably above the level of the sea, and previous to its junction therewith.

In ascending the high ground on the south-east side of the bay, sandstone rocks were observed regularly stratified, and having a S.E. dip. Nearest the shore, quartzy sandstone prevails,

of a close subgranular structure, with interspersed grains of red felspar. This includes beds of coarse quartzy slate-clay, and fine sandstone conglomerate. This last seems to differ from the quartzy sandstone (or Quartz-rock as it is also called), chiefly in the grains being rounded, distinct, from a tenth to a twentieth of an inch in diameter, and connected by an alumino-siliceous cement, which is small in quantity, and easily decomposed by the action of the weather. Higher up in the hill, the coarse, thick, slaty clay prevails, passing in several places into an irregularly granular, impure, yellowish-coloured limestone, with disseminated iron-glance. Above this the quartzy sandstone again appears, until at the summit a dense slaty rock occurs, consisting of quartz and mica, which I was inclined to term slaty sandstone, from its connections with the beds I had so recently passed over; though, had I approached it through a gneiss region, I would, without hesitation, have pronounced it coarse mica slate. In this last rock, portions of a coarse-grained, blue limestone occur, exhibiting some appearances of being a fine conglomerate.

While employed in turning over some stones, in search of marine animals, near low-water mark, I met with the *Chiton lævis* of Pennant (*British Zoology*, iv. tab. xxxvi. f. 3.), which he states as inhabiting the shores of Loch Broom. This species is the *Chiton ruber* of Fabricius, and other continental naturalists. It is not the Chiton lævis of Montagu, described in Testacea Britannica. The *lævis* of the latter author is distinguished from all the other native species (except the Ch. *albus*, with which it is not apt to be confounded,) by its reticular border, and from the *lævis* of Pennant, in wanting the longitudinal coloured band. Pennant's shell is common on all parts of the Scottish coast. It is probably the Patella articulata cymbiformis of Wallace, ("Orkney," p. 41.), at least the figure which he has given is expressive of its ordinary appearance. The *lævis* of Montagu is of rarer occurrence. His specimens were procured in Salcomb Bay, Devonshire. I have found it in Bressay Sound, Zetland. Our specimens agree in every particular with those from Devon, which were sent to us from Mr Montagu several years before his death. While the *Chiton lævis* of Pennant must be considered as synonimous with *ruber*, the *Ch. lævis*

of Montagu must be regarded as an independent species. Along with Chiton ruber the *Ch. marymatus* and *cinereus* were rather common.

When on board, I trawled up, by means of a grapple, some splendid examples of *Laminaria saccharina* and *bulbosa*, along with several marine animals of the rarer kinds. A single specimen of the *Terebratula aurita* (which I have described and figured in my Philosophy of Zoology, vol. ii. p. 498, Pl. iv. f. 5. where Stornaway is, by mistake, marked as the habitat, instead of Ullapool) here found, was peculiarly gratifying, as constituting the third brachiopodous bivalve which I have had the good fortune to add to the British Fauna. I likewise found the *Murex reticulatus*, *Nerita pallidula*, *Cardium fasciatum*, *Venus virginea* and *pullastra*, and *Patella hungarica*, of Testacea Britannica. A single specimen of the *Tritonia arborescens* occurred. *Asterias fragilis*, *aculeata*, *purpurea* and *glacialis* seemed to be common. A fragment of one arm of the latter of these was found in progress of forming a mouth and new rays. Its appearance was indeed singular, and for some time puzzling. The *Amphitrite ventilabrum* of Sowerby's British Miscellany, and a *Nereis*, probably the *pinnata* of Zool. Dan. Tab. xxix. Fig. 1–3. were likewise procured. Some boys in a boat alongside, who were fishing whitings, caught a crested-blenny (*Blennius Galerita*), an occurrence which they stated to be frequent.

We left Lochbroom on the morning of the 17th, on our return to Scalpa, which we reached on the morning of the 18th. In the stomach of cod-fish (often a rich storehouse for the zoologist), taken in the channel, besides abundance of Asterias fragilis and aculeata, the following crustaceous animals occurred. *Portunus puber*, the *Cancer velutinus* of Pennant, very common in the Hebrides, and known by the term *Keshokcrupen*;—*Gonoplax angulatus*,—*Cancer asper* of Pennant, which had been dressed with fragments of the smaller fuci,—Galathea strigosa, and Nephrops Norvegicus.

(To be concluded in our next Number.)

Art. X.—*Observations on the formation of Mists, and the deposition of Dew.* By George Harvey, Esq., M. G. S., &c. Communicated by the Author.

FOR the formation of mists, it is necessary that the temperature of the water should be *greater* than that of the air; but for the deposition of dew, that the heat of the body on which it is to be deposited, should be *less* than that of the atmosphere. For the knowledge of the former of these principles we are indebted to the sagacity of Sir Humphry Davy; and for the latter to the late lamented Dr Wells.

Previous to the time of Dr Wells, it was supposed by Mr Wilson and Mr Six, that the cold connected with the formation of dew ought always to be *proportional* to the quantity of that fluid; and the first mentioned philosopher had the credit of showing, that "the *same* degree of cold in the precipitating body, may be attended with *much*, with *little*, or *no* dew, according to the existing state of the atmosphere, in regard to moisture. As the *difference* of temperature, therefore, between the precipitating body and the air, is not to be regarded as a proper measure of the quantity of dew deposited on a clear and tranquil night; neither is the *difference* between the temperatures of water and air to be considered as at all proportional to the density of a mist. The *quantity* of aqueous vapour contained in the atmosphere, is as necessary for the copious formation of mist, as for the abundant deposition of dew.

There are three principal conditions to be considered, when the formation of dew is taken in conjunction with that of mist. In the first place, the temperature of the water, and the law according to which it cools; secondly, the temperature of the land, and the law by which it radiates its heat to the sky; and, thirdly, the quantity of vapour contained in the air. The varied character of these conditions must necessarily impart a corresponding diversity to the results. The same circumstances of temperature, which in one case would produce a copious deposition of dew, and a mist of considerable density, in another case would produce only a moderate formation of each; and even if we suppose the quantity of atmospheric moisture to remain constant, alterations of temperature will occasion innumerable varieties of both.

When the atmosphere is completely saturated with vapour, the greatest quantity of dew will be deposited, when the land, by a free radiation to a pure and tranquil sky, has its temperature diminished by the greatest possible quantity *below* that of the air reposing on its surface; and a mist of the greatest degree of density will be formed, when the temperature of the adjacent water is *above* that of its superincumbent air, also by the greatest possible quantity. The temperatures of the two masses of air, although unequal, may therefore be regarded as occupying a kind of middle state between the extremes here alluded to.

In all cases the density of a mist will be jointly proportional to the difference of temperature between the sea and land, and the quantity of vapour held in solution by the atmosphere at the time of its formation.

To show, however, the quantities of moisture that will be precipitated in the form of mist, fog, or rain, from the mingling together of equal masses of perfectly saturated air, of different degrees of temperature, the following examples are given; and from which it will be perceived, that the moisture deposited increases with the difference of temperature of the volumes of air. The temperatures are those of the centesimal scale; and the grains of vapour are what a metrical cube of air contains at the respective temperatures, when in a state of saturation, according to the experiments of Professor Leslie.

Temperatures.	Grains of Vapour dissolved in a metrical cube of Air, at the respective Temperatures.	Means of the preceding.	Grains of Vapour dissolved in a metrical cube of Air, at the means of the respective Temperatures.	Grains of Vapour deposited in the form of Mist, Fog, or Rain.
4° 6	120.3 132.0	126.1	126.0	0.1
4 8	120.3 144.7	132.5	132.0	0.5
4 10	120.3 158.7	139.5	138.2	1.3
4 12	120.3 174.1	147.2	144.7	2.5
4 14	120.3 191.0	155.6	151.6	4.0
4 16	120.3 209.5	164.9	158.7	6.2
4 18	120.3 229.7	175.0	166.2	8.8
4 20	120.3 252.0	186.1	174.1	12.0

From this Table it appears, that when the difference between the temperatures of the two metrical cubes of air amount to two centesimal degrees, the quantity of vapour deposited by a metrical cube of the mixed air, amounts only to $\frac{1}{10}$th of a grain, whereas the union of similar volumes at the temperatures of 4° and 20°, occasions a precipitation of 12 grains. The greater the difference, therefore, between the temperatures of the equal masses of air, the greater will be the density of the mist formed by their union.

It does not follow, however, that nature, in the infinite diversity of her operations, is confined, as in the particular case here considered, to the mingling together of *equal* volumes of perfectly saturated air, or of air containing a less proportion of moisture. Two or more parts of one particular temperature, and with any assignable degree of moisture, may be blended with other proportions of air, of a different temperature, and having other relations of moisture; and from such will arise mists of every variety of density.

Circumstances may be favourable to the deposition of dew on the borders of rivers, without contributing to the formation of mists. The atmosphere contains, at all times, some moisture; and, therefore, when the relations of the temperature of the air and land are suitable, and a clear and tranquil sky prevails, a deposition of dew of some degree or other will take place. But, although the relations of temperature between the land and water may be favourable to the formation of mist, it by no means follows that the union of volumes of air, of unequal temperatures, will produce a *visible* condensation *. In some examples which I have witnessed, the extreme tenuity of the mist has indicated, that the circumstances of temperature and vapour were such as just to admit of its formation.

The deposition of dew must always precede the formation of mists. This will appear evident, when we consider the principles to which each owes its origin. Suppose at some moment an equality of temperature to take place between the water, the

* See Dr James Hutton's paper on the Theory of Rain, Vol. I. p. 47. of the *Transactions* of the *Royal Society* of Edinburgh.

land, and the volumes of air reposing over each. In consequence of the unequal cooling powers of the land and water, the former will *first* have its temperature reduced below that of the air; and although by this diminution the equality of temperature between the two volumes of air will be destroyed, and a condition created favourable to the formation of mist; still, as the cooling of the first volume, and the mingling of the two are not cotemporaneous acts, dew will be the first deposited.

In proportion, however, as the land radiates freely, with the same rapidity must the temperature of the superincumbent air be diminished, and the equilibrium between it and the atmosphere hovering over the water be disturbed. The rapid formation of dew, is therefore accompanied by circumstances favourable to the quick formation of mist; and it hence becomes probable, that, under such conditions, mist will be formed at an earlier period of the night, than when the land radiates less copiously, and dew is deposited in less abundance.

If, in consequence of the interposition of a canopy of clouds, the cooling of the land and water should be checked, and an equality of temperature be restored between the two masses of air, and the bodies on which they respectively repose, the deposition of dew will be suspended, and likewise all tendency to the farther formation of mist. The entire dissipation of the latter may likewise result from the change.

Or, if we suppose a temporary interposition of clouds, and conceive the land to radiate its heat only at intervals, corresponding changes of temperature will immediately follow; an increase of heat taking place when the sky is obscured, and a diminution when its clearness is restored. Dr Wells has furnished a case, wherein the temperature of grass increased 15° in the short space of forty-five minutes, and which was at the same time accompanied by an elevation in the temperature of the air of three degrees and a half. Nor is it improbable but that examples sometimes occur, of dew and mist being deposited in the former part of the night, and both disappearing before the morning; or, as it may sometimes happen, the former be preserved, and the latter dissipated. The first of these phenomena may take place, when a portion of the night, favourable to the formation both of mist and dew, is succeeded by a brisk wind;

and the second, when, by the interposition of dense clouds, the temperature of the land is raised, and which, by imparting its influence to its superincumbent air, restores it to a temperature equal to, or even greater than that of the atmosphere reposing on the water, ultimately causing the mist to disappear, from the increased capacity of the air for vapour. This latter circumstance will also account for the dispersion of mists in the morning, before the disappearance of dew.

The gentle motion that must also take place, from the mingling of the cold air from the land with the warmer air above the water, will have a tendency to increase the deposition of dew, since new volumes of air will be successively brought into contact with the cold surface of the earth, and which, by depositing their moisture, will augment the quantity of dew beyond what would otherwise have been formed, had the atmosphere remained perfectly calm. Dr Wells found, that a slight agitation of the air was always accompanied with an increase of dew.

The general tenor of these observations is in some degree confirmed by a remark of the same indefatigable observer, that "dew is always very copious on those clear and calm nights which are followed by misty or foggy mornings."

PLYMOUTH,
July 10. 1823.

ART. XI.—*Description of Five New Genera of Plants, belonging to the Natural Order Bignoniaceæ.* By Mr DAVID DON, Librarian to the Linnean Society, Corresponding Member of the Wernerian Natural History Society *, &c.

AMONG the numerous tribes of vegetables which people the vast regions of equinoctial America, the *Bignoniaceæ* hold a distinguished rank, whether as regarded for the beauty of their flowers and the diversity of their forms, which give to the vegetation peculiar features, or as objects highly deserving the attention and investigation of the botanist. Perhaps in no tribe of plants, does the form of vegetation assume such variety as in this extensive family. In the beautiful genus *Jacaranda*, are

* Read before the Wernerian Natural History Society, 23d April 1823.

contained the loftiest trees to be met with, either in this or any of the neighbouring orders. These splendid trees, which are entirely wanting in the ancient Continent, form one of the bright est ornaments of the forests of tropical America. Notwithstanding the apparent facility which attends the division of this order, on account of the size of the parts of fructification, yet none of the allied orders are less understood, or contain fewer genera, in proportion to the number of species. We are apt to place the *Bignoniaceæ* among the smaller tribes of vegetables; but in thus viewing it, we do not consider the great number of species remaining to be described in our Herbariums. In judging from the number already known to be natives of tropical America, I am led to think, that, when these vast countries are explored, the number will be very greatly augmented.

The genus *Bignonia*, as constituted by Linnæus, contained an assemblage of plants, which, generically considered, were widely different from each other. To Jussieu we are indebted, for having set us an example worthy of imitation, by his judicious division of this overgrown genus. It is the great advantage which a natural system possesses over all artificial methods in the studying of vegetables, that it teaches us to examine and group them according to their respective affinities; and to give to the different parts their relative importance in characterizing genera.

Willdenow, and almost all those botanists who have followed the Linnæan artificial method of classification, have left the genus *Bignonia* untouched, without even adopting the important divisions proposed by M. de Jussieu.

It is not my intention here to give a complete illustration of the order; I shall confine myself merely to giving the characters of the new genera which I have proposed. Perhaps, in a future number of this Journal, I may give some further illustration of this family of plants, as well as that of *Sesameæ*, to which it is nearly related; and on which I have, I trust, been enabled to collect some interesting materials.

CHARACTERES GENERUM.

ARGYLIA.

BIGNONIÆ sp. *Lin. et Auctor.*

Calyx profundè 5-fidus, æqualis. *Corolla* basi tubulosa, supernè dilatata, campanulata, subtùs ventricosa, limbo 5-loba,

subbilabiata: *lobis* latè rotundatis, æqualibus, margine undulatis. *Stamina* 4, didynama absque rudimento sterilis. *Antheræ* barbatæ: *lobis* æqualibus, patenti-divaricatis, apice ferè distinctis. *Capsula* siliquæformis, compressa, bilocularis. *Dissepimentum* valvis parallelum. *Semina* transversa, margine membranacea.

Herba *(Peruviana) perennis, virens.* Radix *crassa, divisa, carnosa, fusiformis.* Caulis *erectus, pedalis, teres, ramulosus, viscidus, pubescens, crassitudine pennæ anserinæ v. rariùs digiti minoris, carnosus.* Folia *alterna, sæpiùs spithamea, remota; compositè peltato-digitata, petiolata;* partialibus *profundè bi v. tripinnatifidis, inæqualibus, patentibus, in circulum-digestis, minutè pubescentibus viscidisque:* segmentis *linearibus cuneato-oblongisve, obtusissimis, integerrimis, carnosis, inæqualibus.* Petioli *longi cylindracei, 3–6-pollicares, carnosi, crassitudine pennæ corvinæ v. anserinæ.* Pedunculus *caulis continuus teres, carnosus, viscido-pubescens.* Flores *terminales, spicati, numerosi* (12.–18). Pedicelli *remotè alterni, breves, stricti, uniflori, semiunciales, singuli basi bracteolo angustè lineari iisdem breviore suffulti, calycesque tomentosi.* Laciniæ calycinæ *lineares, acutæ, rectæ, subæquales.* Corollæ *amplæ, luteæ, magnitudine* Catalpæ syringifoliæ, *speciosæ, intra faucem punctis numerosis rubris notatæ.* Stamina *inclusa.* Ovarium *compressum, lineare, ensiforme.* Stylus *staminibus longior, filiformis, gracilis, glaber.* Stigma *bilamellatum:* lobis *ovali-oblongis, acutis, replicatis.*

A. radiata.

Bignonia radiata, *Lin.*

This beautiful new genus I have dedicated to the memory of Archibald, Duke of Argyle, a nobleman distinguished for his patriotic virtues and love of science, and more especially of botany. His fine garden at Whitton Park, in Middlesex, was justly celebrated towards the middle of the last century. It contained a very extensive collection of plants, particularly of ornamental and useful American trees, many of which he himself first introduced to this country. There are many fine specimens of Argylia in the Lambertian Herbarium, from Don Jose Pavon, collected in the Peruvian expedition. Linnæus, and all other botanists, without having seen the plant, have very improperly referred it to *Bignonia*, and to give their opinion, perhaps, the more weight, they have marked it as shrubby. The figure given by Father Fewillie is much too diminutive, and is calculated to convey but a very imperfect idea of this elegant plant.

CHILOPSIS.

Calyx membranaceus, oblongus, ventricosus, lateri inferiori ad basin usque fissus: *limbo* obliquo, supernè tridentato *Co*

rolla basi tubulosa, fauce dilatata, campanulata, limbo 5-loba, bilabiata: *lobis* ovali-rotundatis, margine crispato-crenatis; *infimo* maximo, oblongo. *Stamina* 4, didynama, fertilia; *quinti* rudimentum sterile, breve, glabrum. *Antheræ*, nudæ: *lobis* æqualibus, divaricatis. *Capsula* brevis, siliquosa, bilocularis. *Dissepimentum* contrarium, placentiferum. *Semina* transversa, margine membranacea.

Frutex (*Mexicanus*), *erectus*, *ramosus*. Rami *teretes*, *pubescentes*. Folia *alterna*, *linearia*, *plana*, *elongata*, *3–5 pollicares longa*, *glabra*, *coriacea*, *basin et apicem versus attenuata*. Spica *terminalis*, *brevis*, *densa*, *tomentosa*. Flores *brevè pedicellati*, *bracteolis duabus lineari-lanceolatis muniti*. Corollæ *atro-purpureæ*, *magnitudine* Chelonis. Ovarium *oblongum*, *compressum*. Stylus *filiformis*, *glaber*, *stamina longiora æquans*. Stigma *bilamellatum*: laciniis *ovali-oblongis*, *obtusis*, *æqualibus*, *replicatis*.

C. Saligna.

An elegant shrub, native of Mexico, from whence fine specimens have been received by Don Jose Pavon, and by him transmitted to Mr Lambert. It forms a very distinct and well-marked genus, readily distinguished from *Spathodea* by the structure of its capsule, and by having simple alternate leaves. I have named it *Chilopsis*, from χειλος, *labium*, and οψ, *facies*, on account of the corolla being furnished with a distinct lip.

ASTIANTHUS.

Calyx tubulosus, limbo quinquedentatus, æqualis. *Corolla* basi tubulosa, fauce dilatata, ventricosa, campanulata: *limbo* 5-lobo, bilabiato; *labio inferiore* trilobo, lobo medio maximo. *Stamina* 4, fertilia, didynama; *quinti sterilis* rudimento breviore, glabro. *Antheræ* nudæ: *lobis* æqualibus, confluentibus. *Capsula* longissima, siliquosa, bilocularis. *Dissepimentum* valvis parallelum, crassum, utrinque placentiferum. *Semina* transversa, compressa, margine alata et villis numerosis papposa.

Frutex (*Mexicanus*), *erectus*, *ramosus*, *frondosus*. Rami *teretes*, *glabri*. Folia *terna*, *simplicia*, *elongata*, *latè linearia*, *coriacea*, *integerrima*, *glabra*, *6—10-pollicaria*, *latitudine 2-lineari v. semiunciali*, *uninervia*, *utrinque attenuata*. Flores *terminales*, *numerosi*, *paniculati*. Calyces *oblongi*, *tubulosi*, *limbo æquales*, *5-dentati*, *glabri*. Corollæ *amplæ*, *campanulatæ*, *basi tubulosæ*, *rubro-purpureæ*, Digitali purpureâ *majores*: limbo *5-lobo*, *bilabiato*; labio superiore *bilobo*, *reflexo*; inferiore *trilobo patente*, *longiore*, lobis *latissimis*, *rotundatis*, *margine crispatis crosisque*. Stylus *erectus*, *filiformis*, *robustus*, *glaber*, *staminibus longior*. Stigma *bilamellatum*: laciniis *oblongis*, *obtusis*, *æqualibus*. Capsula *longissima* (*6-uncialis*), *siliquosa*, *compressa*, *bilocularis*,

polysperma: valvis *coriaceis*. Dissepimentum *parallelum*, *crassum*, *utrinque placentiferum*. Semina *compresso-plana*, *transversa*, *margine alata atque villis numerosis papposa*: testa *duplex*, *utraque membranacea*: albumen *nullum*. Embryo *magnus*, *transversus*, *rectus*: cotyledones *maximæ*, *foliaceæ*, *bilobæ*, *reniformes*: radicula *brevissima*, *recta*, *teres*, *centrifuga*; *basi obtusa*.

A. longifolius.

I was fortunate in meeting with numerous fine specimens of this splendid shrub, among many other new bignoniaceous plants, in an extensive Mexican collection lately received from Don Jose Pavon, and now deposited in the Lambertian Herbarium. It forms a genus totally different from any hitherto published. It is distinguised from *Bignonia* by the confluent lobes of its anther, by its seeds being furnished with a villous pappus, and, lastly, by its habit. It differs from *Tecoma*, besides the characters above enumerated, in having a parallel, and not a transverse dissepiment, and from *Spathodea* (with some plants referred to which, it agrees in habit) it is readily distinguished by the structure of its capsule, in having seeds furnished with a villous pappus, and, lastly, by the lobes of the anthers being confluent. The name, which I have given it, alludes to its brilliant flowers, and is derived from αστειος, *venustus*, and ανθος, *flos*.

DELOSTOMA.

BIGNONIÆ sp. *Pavon MSS.*

Calyx campanulatus, trilobus, coriaceus. *Corolla* infundibuliformis, fauce dilatata, limbo patula, bilabiata; *labio inferiore* trilobo; *superiore* breviore, bilobo: *lobis* latis, rotundatis, planis. *Stamina* 4, didynama, antherifera; *quinto* sterili, brevi, glabro. *Antherarum* lobis parallelis, æqualibus. *Stigma* latum, bilamellosum. *Capsula* lanceolata, compressa, bilocularis: *valvis* coriaceis, subcarnosis. *Dissepimentum* parallelum. *Semina* plana, transversa, margine latè membranacea.

Arbores (*Peruvianæ*), *frondosæ*. Folia *simplicia*, *opposita*, *elliptica*, *petiolata*, *obtusè acuminata*. Flores *terminales*, *spicato-racemosi*, *magni*, *rosei*.

The campanulate, trilobed calyx, the figure of the corolla, the parallel lobes of the anthers, and the structure and form of the capsule, are the marks which characterise this genus. The species referable to this genus are the two following, viz.

1. *D. dentatum*, foliis elliptico-oblongis dentatis subtùs pubescentibus.

Bignonia rosea, *Pavon MSS.*

Hab. in Peruviâ. *Pavon* ♄. (v. s. in Herb. Lamb.)

2. *D. integrifolium*, foliis ellipticis integerrimis subtùs tomentosis.

Bignonia simplicifolia, *Pavon MSS.*

Hab. in Peruviâ. *Pavon* ♄. (v. s. in Herb. Lamb.)

The generic name is derived from δηλος, *manifestus*, and στομα, *os*, in allusion to the wide mouth of the flower.

STENOLOBIUM.

Bignoniæ sp. *Pavon MSS.*

Calyx parvus, campanulatus, 5-dentatus, æqualis. *Corolla* basi angustè tubulosa: *fauce* valdè dilatatâ, inflatâ, campanulatâ: *limbus* 5-lobus, æqualis, [illegible] tus. *Stamina* 4, fertilia, didynama: *quinti* rudimento brevissimo, glabro. *Antherarum* lobis linearibus, patenti-divaricatis. *Capsula* angustè linearis, siliquosa, compressa, bilocularis. *Dissepimentum* parallelum. *Semina* plana, transversa, margine membranacea.

Arbor *(Peruviana)*, *frondosa*, *erecta*. Folia *simplicia*, *opposita*, *ferè* Castaneæ, *elliptica*, *coriacea*, *acuta*, *penninervia*, *petiolata*, *margine serrata*, *subtùs tomento stellato copioso vestita*, *5—7-pollicaria*, *2—3-uncias lata*, *suprà glabra*. Flores *terminales*, *numerosi*, *spicato-paniculati*, *rubro-purpurei*, *magnitudine* Jacarandæ. Stylus *staminibus brevior*, *gracilis*. Stigma *bilamellatum*. Capsula *5-pollicaris*.

Obs. Nomen duxi è στενος, *angustus*, et λοβος, *siliqua*, ob siliquam angustissimam.

S. castanifolium.

Bignonia serrata, *Pavon MSS.*

Hab. in Peruviæ sylvis ad Huayaquil. *Pavon.* ♄. (v. s. in Herb. Lamb.)

JACARANDA *Juss.*

Bignoniæ sp. *Lin Willd.*

Calyx campanulatus, 5-dentatus, raró tubulosus, truncatus, integer. *Corolla* basi tubulosa, supernè valdè dilatata, campanulata, subtùs ventricosa: *limbo* 5-lobo, bilabiato. *Stamina* 4, didynama; *quintum* sterile, longius, supernè villoso-barbatum. *Antheræ* in *plerisque* unilobæ! alteri lobi rudimento obsoleto, raró (in *tomentosâ*) bilobæ lobis æqualibus divergentibus. *Capsula* lata, compressa, bilocularis: *valvis* crassis, ligneis. *Dissepimentum* valvis contrarium, utrinque placentiferum. *Semina* plana, transversa, margine foliaceo-alata; *testa* exterior, coriacea, rugoso-plicata.

Arbores *(Amer. Æquin.)* *pulcherrimi*, Mimosæ *facie*, *sæpè elati*. Folia *opposita*, *bipinnata*. Flores *speciosi*, *paniculati*, *terminales raró laterales*, *cærulei*, *violacei v. lutei*.

This genus is rendered interesting by the anomalous structure of the antheræ, observable in the greater part of the species

referable to it. Every botanist knows, that the anthers in this family of plants are parted into two divaricately spreading, rarely parallel, or, more strictly speaking, confluent unilocular lobes. These lobes, in most cases, are united together at their axis; but in *Argylia* the connection is so slight, that they appear as if quite distinct. In *Jacaranda*, however, one of the lobes is abortive, with only a faint rudiment of the other. This remarkable character of the anthers in *Jacaranda* first attracted my attention in examining the *Jacaranda mimosifolia*, which flowered last year in the hot-house belonging to the Comtesse de Vandes at Bayswater. At first, I was inclined to consider it as merely an accidental malformation of the anther; but, from having afterwards found it to be an invariable structure in five species out of the six, which are referable to this genus, I was led to regard it as an important mark, not undeserving a place in the generic character. The only known exception is the *Jacaranda tomentosa*, wherein the anthers consist of two equal diverging lobes. In other respects, this species accords with its congeners, unless in having its leaves terminated by an odd *pinna*. The structure of the outer covering of the seed will be found to furnish a character of considerable importance. I shall here subjoin descriptions of the species belonging to this genus.

§ *Antheris unilobis, foliis abruptè bipinnatis.*

1. *J. acutifolia*, foliis bipinnatis subsexjugis: foliolis lineari-lanceolatis acuminatis glabris, corollis sericeis: tubo recto.

Jacaranda acutifolia, *Humb. et Bonpl. Pl. Æquin.* 1. *p.* 59. *t.* 17. *Kunth in Nov. Gen. et Sp. Pl.* 3. *p.* 145.

Hab. propè San Phelipe, in Peruviæ calidis, ad ripas fluvii Guancabamba. *Humboldt et Bonpland.* ♄.

Arbor ramosa, 10-pedalis, cortice rimoso cinereo obducta. *Rami* numerosi, patuli, elongati, foliosi. *Folia* opposita, patentia, bipinnata, abruptè paucijuga spithamea: *pinnæ* alternæ, per paria remotæ, in jugis 5 v. 6 absque impari dispositæ: *foliolis* 9–12-jugis, oppositis alternisve, lineari-lanceolatis, acuminatis, glabris, ferè uncialibus. *Paniculæ* terminales, amplæ, pyramidatæ, multifloræ. *Calyces* campanulati, 5-dentati: *dentibus* ovatis, acutis. *Corollæ* magnæ, violaceæ, extùs sericeæ: *tubus* rectus fauce duplo brevior: *faux* dilatata, campanulata, subtùs ventricosa: *limbus* 5-lobus, bilabiatus: *lobis* rotundatis, margine paulò crispatis. *Stamina* 4, didynama, fertilia, per paria fornicato-conniventia; *quintum* sterile, multò longius, supernè villosum, infernè attenuatum et glabrum. *Antheræ* unilobæ, alteri lobi rudimento vix ullo. *Ovarium* ovale, compressum. *Stylus* filiformis, glaber. *Stigma* bilamellatum. *Capsula* lignosa, ovalis, compressa, subacuta, bilocularis, bivalvis, 2½-pollicaris, latitudine 1½-unciali: *dissepimentum* contrarium, carnosum, utrinque placentiferum. *Semina* crebra, plana, transversa, margine membranacea.

2. *J. obtusifolia*, foliis bipinnatis multijugis: foliolis ovali-oblongis obtusis pubescentibus, corollis glabris: tubo arcuato fauce triplò breviore.

Jacaranda obtusifolia, *Humb. et Bonpl. Pl. Æquin.* 1. *p.* 62. *t.* 18. *Kunth in Nov. Gen. et Sp. Pl.* III. *p.* 145.

Hab. juxta Carichana in umbrosis ad ripas Orinocco fluminis. *Humboldt et Bonpland.* ♄. Arbol del roseto *Colonis*.

Arbor ampla, 30-pedalis, ramosa: *truncus* strictus, 12-pedes altus, diametro 1-pedali, supernè divisus. *Rami* elongati, iterum et iterum divisi, cortice cinereo rugoso obducti. *Folia* opposita, patentissima, pedalia, bipinnata, abruptè multijuga: *pinnæ* numerosæ, alternæ v. oppositæ, subdistantes, in jugis 15 digestæ; *foliolis* ovali-oblongis, obtusis, alternis oppositisve, contiguis, margine paulò reflexis, suprà pubescentibus. *Paniculæ* amplæ, multifloræ, diffusæ, sæpiùs laterales. *Calyces* parvi, campanulati, 5-dentati: *dentibus* acutis, æqualibus. *Corollæ* violaceæ, glabræ, *J. mimosifoliâ* majores: *tubus* basi inflatus, medio constrictus, anfracto-arcuatus, fauce triplò brevior: *faux* valdè dilatata, inflata: *limbus* 5-lobus, bilabiatus: *lobis* rotundatis, planis. *Stamina* 4, didynama, fertilia; *quintum* sterile, multò longiùs, supernè villosum: *filamenta* fertilium glabra, arcuata: *antheræ* unilobæ, per paria conniventes. *Ovarium* ovale, ancipiti-compressum. *Stylus* filiformis, glaber. *Stigma* bilamellatum. *Capsula*...........

3. *J. mimosifolia*, foliis bipinnatis multijugis: foliolis trapezoidi-ovalibus oblongis mucronatis pubescentibus; impari lanceolato longiore, corollis sericeis: tubo subarcuato fauce triplò breviore.

Jacaranda mimosifolia, *Don in Bot. Reg. t.* 631. Jacaranda ovalifolia, *Brown in Bot. Mag. t.* 2327.

Hab. in Braziliâ. ♄. (v. v. c.)

Arbor (caldario culta) suborgyalis, gracilis, erecta, cortice cinereo, infernè cicatricibus nodosa: *ramorum caulisque* pars novella lætè virens et guttis crystallizatis sparsa. *Folia* decussato-opposita, patentissima, distantia, bipinnata, oblonga, villosa, miculis crystallinis inæqualissimis adspersa, palmaria ad sesquipedalia: *pinnæ* oppositæ, lineari-oblongæ, abruptè multi-(14–24)-jugæ, 2–3-unciales, approximatæ cum rachide communi canaliculata in marginem brevem erectam viridiorem utrinque attenuata: *pinnulæ* parvæ, decursivæ, oppositæ v. subalternæ, impari-multi-(10–28)-jugæ, contiguæ, trapezoidi-ovales, oblongæ, mucronatæ, 3-4 lineares aut magìs, peripheria subdeflexæ, subtùs pallentes venisque reticulatæ; *impari* terminali, erecto, longiore, lanceolato: *rachis* angustè alata. *Panicula* ampla, nuda, terminalis, multiflora, erecto-pyramidata, remota, decussato-ramosa, villosa, patentissima, rachide virente cum ramulis bi-trifidis per paria dispositis pedicellisque compressiusculis: *bracteæ* minimæ, caducæ. *Flores* speciosi, nutantes, cœrulescentes, sericei. *Calyx* herbaceus, minimus, villosus, 5-dentatus. *Corolla* oblongo-tubulosa, campanulato-bilabiata, sesquiuncia longior, pube minutâ appressâ densâ extùs vestita: *tubus* subarcuatus, compressiusculus, in faucem 3-plò longiorem depresso-campanulatam subtùs ventricosam plicisque nonnullis longitudinalibus striatam dilatatus: *limbus* brevis, quinquelobus, sursùm obliquatus, *lobis* rotundatus intus villosis; *labii inferioris* laciniæ trinæ, margine subcrispatæ et eroso-repandæ, medio cæteris porrectior; *superioris* brevioris breviùsque fissi laciniæ binæ, reflexæ, medio infernè albæ. *Stamina* 5–4, *fertilia* ochroleuca, fauce duplo breviora, summo tubo inserta, ex utrinque per paria conniventia (pari inferiore paulò breviore): *filamenta* infernè secundum latus internum pilis flavo-capitatis (sterilis consimilibus), cristata: 1 *sterile* rectum, fauce exsertum, medio albo-barbatum, penicillo corollæ concolori terminatum, de infra medium deorsùm attenuatum atque glabrum: *antheræ* (ob loculum inferiorem castratum) unilobæ, lineari-oblongæ, ochroleucæ: *loculus* cucullato-dehiscens, receptaculo fusco adnatus. *Germen* ovato-oblongum, acuminatum compressum, nudiusculum, biloculare, *dissepimento* contrario, utrinque placentifero. *Stylus* glaber, partìm persistens. *Stigma* cuspis oblonga, styli continua, compressa, acuta, bilamelloso-partita, styli concolor, extùs lævis: *lobis* replicatis. *Don in loc. cit.*

4. *J. filicifolia*, foliis bipinnatis multijugis: foliolis trapezoidi-ovalibus mucronulatis glabris coriaceis; impari elliptico-rhomboideo acuto maximo, corollis glabris: tubo arcuato faucem subæquante.

Jacaranda rhombifolia, *Mey. Prim. Fl. Esseq. p.* 213.

Bignonia filicifolia, *Anderson, Cat. Hort. St Vincent. in Trans. Soc. Arts, &c. Vol.* XXV. 1807. p. 200.

Hab. ad Essequebo flumen in sylvis. *Anderson.* ♄. (v. s. in Herb. Lamb.

Arbor erecta, pulcherrima, 25 ad 40 pedes alta. *Rami* assurgentes, elongati, teretes, cicatricibus latis e foliis delapsis ortum ducentibus notati, atque cortice cinereo obducti. *Folia* ampla, patentissima, elegantia, ferè *Mimosæ* bipinnata, abruptè multijuga, decussato-opposita, distantia, palmaria v. pedalia, nunc sesquipedalia: *pinnæ* oppositæ in jugis 9 v. 18 subdistantes: *foliolis* plerumque oppositis, subsessilibus, trapezoidi-ovalibus, mucronulatis, coriaceis, integerrimis, suprà glabris nitidisque, viridibus, subtùs glaucis, ad basin nervi medii pilosis, margine paulò deflexis, in jugis 6 v. 15 contiguis cum *impari* maximo rhombeo-elliptico acuto. *Petioli* cum *rachibus communibus* teretes, firmi, basi valdè incrassati, suprà canaliculati; *partialibus* subtèr carinatis, ad peripheriam alatis, versus apicem latioribus magìsque foliaceis. *Paniculæ* parvæ, laterales et terminales, decussato-ramosæ: *ramis* variè dichotomis raro subsimplicibus. *Flores* speciosi, in *terminalibus* numerosi, in *lateralibus* pauciores. *Pedicelli* bi v. trifidi, glabri. *Calyces* parvi, campanulati, quinquedentati: *dentibus* minimis, acutis. *Corolla* magna, violacea: *tubus* angustè cylindraceus, arcuatus, in faucem inflatam campanulatam subtùs ventricosam suprà depressam ipso vix longiorem dilatatus: *limbus* 5-lobus, bilabiatus; *labio inferiore* trilobo, patente; *superiore* bilobo, reflexo, *lobis* rotundatis, paulò crispatis et eroso-repandis. *Stamina* 5, quorum 4 fertilia et didynama, inclusa; *quintum* sterile, cæteris multò longius, extra faucem exsertum, supernè villosum. *Antheræ* unilobæ per paria conniventes, *alteri* lobi rudimento minutissimo. *Ovarium* ellipticum, compressum, biloculare *dissepimento* contrario utrinque placentifero. *Stylus* filiformis, gracilis, glaber, partim persistens et ovarium coronans. *Stigma* bilamellosum: *laciniis* ovalibus, obtusis, replicatis.

5. *J. copaia*, foliis bipinnatis 4–5-jugis: foliolis ellipticis cuneatisve obtusis coriaceis glabris, calycibus tubulosis truncatis, corollis velutinis.

Bignonia copaia, *Aubl. Guj.* 2. *p.* 650. *t.* 265. *et* 262. (pro capsula).
Bignonia procera, *Willd. Sp. Pl.* 3. *p.* 307. *Persoon Syn.* 2. *p.* 173.

Hab. in Guianæ nemoribus. *Aublet, Martin.* ♄. (v. s. in Herb. Lamb.)

Arbor vasta, formosa, sexaginta aut usque octoginta pedes alta, apice ramosa. *Truncus* strictus, diametro 2–3-pedali, cortice crasso cinereo rugoso obductus. *Rami* numerosi, erecti, multidivisi, frondosi. *Folia* ampla, patentia, opposita, bipinnata sine impari, 4–5-juga, decussato-disposita, sesqui v. bipedalia, latitudine 6–10 unciali: *pinnæ* oppositæ, patulæ, per paria remotæ, *rachide* compressâ glabrâ, suprà canaliculatâ: *foliola* opposita, elliptica v. cuneata, obtusa, plana, integerrima, coriacea, glabra, lucida, stipite brevissimo suffulta, per rachin in jugis 3 v. 6 cum impari disposita; bi v. tripollicaria, 1 v. sesqui-unciam lata. *Petioli communes* cum rachide teretes, suprà canaliculati. *Panicula* terminalis, ampla: *rami* oppositi, elongati, recti, cruciatim digesti, multiflori, pubescentes. *Pedunculi* breves, alterni, oppositi aut sparsi, divisi, tri aut pluriflori, pube densâ minutâ tecti. *Calyces* oblongi, tubulosi, truncati, integri, velutini, ad oris latus utrumque fissâ brevissimâ disrupti. *Corolla* cærulea, magnitudine *Digitalis ambiguæ*, basi tubulosa, supernè dilatata, campanulata, ventricosa, limbo 5-lobo, bilabiata, fauce barbatâ, extùs velutina; *labio superiore* bilobo, reflexo; *inferiore* trilobo, patulo, *lobis* subrotundo-ovalibus, margine paulò crispatis. *Stamina* 5, quorum 4 fertilia et didynama; *quintum* sterile, elongatum, supernè villoso-barbatum. *Antheræ* unilobæ, *alteri* lobi rudimento vix ullo, ovatæ, acutiusculæ, demùm patulæ, lateralitèr rimâ longitudinali dehiscentes. *Ovarium* ellipticum, obtusum. *Stylus* erectus filiformis. *Stigma* bilamellosum: *lobis* ovali-oblongis, replicatis. *Capsula* ovalis, compressa, obtusa, bilocularis, polysperma: *valvis* planis, crassis, ligneis. *Dissepimentum* contrarium, utrinque placentis carnosis seminiferis instructum. *Semina* lata, compresso-plana, transversa, margine foliaceo-alata.

§ *Antheræ bilobæ: lobis æqualibus, foliis impari-bipinnatis.*

6. *J. tomentosa*, foliis bipinnatis impari-subquadrijugis: foliolis ovatis ellipticisve acutis inæqualibus subtùs junioribusque tomentosis, corollis sericeis, ramis pubescentibus.

Jacaranda tomentosa, *Brown in Bot. Mag.* (*in observatione ad descriptionem J. ovalifolia suæ supra citatam adjecta.*)

Hab. in Braziliâ. *Georgius Staunton, baronettus. Sello.* ♄. (v. s. in Herb. Lamb.)

Arbor ramis teretibus pubescentibus, cortice cinereo. *Folia* decussato-opposita, bipinnata v. raró simplicitèr pinnata, impari-pauci (3–4)-juga, spithamea, patentia: *pinnis* per paria distantibus, 2–5-jugis; *inferioribus* subsimplicibus: *foliolis* ovatis ellipticisve, acutis acuminatisve, planis, integerrimis oppositis, reticulato-venosis, inæqualibus, sessilibus, ½–2 uncialibus, 3-lineas ad pollicem latis, suprà in *adultis* nudiusculis, nitidis, subtùs junioribusque tomento copioso tectis. *Panicula* parva, terminalis, cano-tomentosa. *Pedunculi* oppositi, filiformes, elongati, 1–3 flori. *Calyces* campanulati, pedicellati, 5-dentati: *dentibus* ovatis, acutis, æqualibus. *Corolla* violacea, extùs sericea, basi tubulosa, supernò ampliata, suprà depressa, infrà ventricosa, limbo 5-loba, bilabiata: *lobis* rotundatis. *Stamina* 4, didynama filamentis gracilibus glabris fornicato-arcuatis; *quinto* sterili, elongato, robustiore, cæteris duplò longiore et extra limbum producto, barbato, apice clavato. *Antheræ* per paria approximatæ, bilobæ: *lobis* oblongis æqualibus divergentibus *Ovarium* ovatum, compressum anceps. *Stylus* filiformis, gracilis, staminibus longior: *stigma* bilamellosum: *laciniis* ovali-oblongis, replicatis. *Capsula* ovali-orbiculata, compressa, sesqui pollicarem longa, latitudine unciali, lævis bilocularis, bivalvis: *valvis* planis, crassis, lignosis. *Dissepimentum* transversum, utrinque placentiferum, *Semina* in loculo singulo numerosa, imbricata, plana, transversa, margine latè foliaceo-alata: *testa* duplex; *exterior* crassiuscula, coriacea extùs plicato-rugosa, fuscescens: *interior* membranacea, diaphana: *albumen* nullum. *Embryo* magnus, foliaceus, lacteus, transversus: *cotyledones* latæ obcordato-reniformes, planæ, applicatæ, extùs convexæ: *radicula* brevissima, subrotunda, centrifuga.

Species sequentes adhuc valdè dubiæ:

Bignonia cœrulea, *Linn. in Sp. Pl.* 872, *quæ* Arbor Guajaci latiore folio, Bignoniæ flore cœruleo, fructu duro in duas partes dissiliente, seminibus alatis imbricatim positis, *Catesb. Carol* 1. *p.* 42. *t.* 42.

Hab. in Bahamæ insulis præsertim Providentiæ juxta urbem Nassau. *Catesby.* ♄.

Jacaranda Brasiliana, *Lam. Encycl.* 1. *p.* 420, *quæ* Bignonia Brasiliana, *Willd. Sp. Pl.* et Jacaranda II., *Pis. Bras.* 165.

ART. XII.—*On the Existence of a group of Moveable Crystals of Carbonate of Lime in a Fluid Cavity of Quartz* *. By DAVID BREWSTER, LL. D. F. R. S. Lond. & Sec. R. S. Edinburgh, &c. &c.

ALTHOUGH particles of opaque solid matter have been observed in the cavities of crystals containing fluid, yet, so far as I can find, no crystallized body, and, indeed, no matter capable of crystallization, has ever been discovered in them. The quantities of saline impregnation, indicated by a scarcely perceptible cloudiness in solutions of silver and muriate of barytes, were so minute in Sir Humphry Davy's experiments, that he considered

* This article forms Sect. VII. of our author's paper on the New Fluid, an abstract of part of which was given in this volume, p. 94.

the water as nearly pure *. I was, therefore, in no small degree surprised, when I discovered, in a cavity of a quartz-crystal from Quebec, from the cabinet of Mr Allan, not only insulated crystals, but a tolerably large group, which were moveable through the fluid upon turning round the specimen †. The crystal was perfectly sound around the cavity, which had a sort of triangular form, one of the sides of the triangle being about one-tenth of an inch long. The fluid was quite transparent; and, as the air-bubble was not perceptibly diminished by heat, there is every reason to think that the fluid is water. The crystals were transparent to a considerable degree, and had a white milky tint, when seen by reflected light.

In considering the circumstances of this singular phenomenon, we are led to suppose, that the included crystals had been dissolved in the fluid at the time of its being shut up in the quartz, and had afterwards been deposited from the solution. The ingenious supposition of Sir Humphry Davy, that a liquid hydrate of silica may exist at high temperatures, and may contain small quantities of atmospheric air, will no doubt explain the phenomena of water in rock-crystals; but it is not easy to comprehend how the formation of a group of crystals could either have accompanied or followed the separation of the water and the silex.

As the specimen now alluded to is too valuable to be destroyed, for the purpose of analysing the minute crystals, it is probable, that our information respecting them would have been very limited, had not a circumstance of an accidental nature enabled me to throw some farther light on the subject. Several years ago, when I was examining, along with Earl Compton, a large collection of quartz-crystals from Quebec, for the purpose of obtaining remarkable crystallizations, I was much struck with the appearance of several spherical groups of whitish crystals, within some of the specimens. Upon pointing out to Lord Compton this peculiarity, his Lordship agreed with me in thinking

* In another part of his interesting paper, Sir Humphry Davy makes the following observation: "The fluid, in all the crystals, (in two it was minutely examined) was found to be water, nearly pure, containing only a minute portion of the alkaline sulphates." *Phil. Trans.* 1822, p. 370.—Ed.

† There were also numerous opaque particles in the cavity, which descended slowly in the fluid.

that they belonged to the Zeolite Family. Having purchased all the specimens that could be found, I have since repeatedly examined the included crystals, with the view of determining their nature. I found that they did not belong to the zeolites, but consisted principally of carbonate of lime; and, as every mineralogist who saw them considered them as something new in appearance, I expected that a greater quantity of them might be found for the purposes of analysis. Familiarised, therefore, with the aspect of these groups, I was convinced that the crystals in the fluid cavity were the same substance; and a more accurate examination has established their perfect identity.

These white crystals sometimes occur in minute insulated spiculæ within the solid mass, but most frequently in spherical groups of extreme beauty, surrounded with the most transparent quartz. Many of the open hollows and crevices of the quartz crystals are filled with them, and numerous aggregated groups adhere to their external surface. These crystals, though very minute, I have found to have a powerful double refraction; and as they are wholly dissolved with effervescence, excepting a little adhering silex, in diluted nitric acid, there can be no doubt that the external crystals, and consequently those in the fluid cavity, are *carbonate of lime* *.

Art. XIII.—*Observations on the presumed Analogy of certain Organs of the Embryo, in several distinct Races of Vascular Plants.* By John Yule, M. D. F. R. S. E. Fellow of the Royal College of Physicians, Edinburgh.

Previous to entering on the detail of the facts, on which the following conclusions are founded, whether true or false, I may be permitted to state, that, in all our inquiries after truth, there is nothing of greater moment than an accurate and definite use of terms: for it is probable, that the neglect of this, more than any other cause, has retarded the progress of the sciences in general. Words used in a loose or improper sense, indeed, do worse than retard: they bewilder and mislead, by substituting

---

* Since these observations were made, Mr Nordenskjold has confirmed this result, by experiments made with the blowpipe.

what is imaginary for reality. This evil has been experienced in a particular manner in our inquiries into the nature of living and organised bodies, in which there is so much obscurity, and so much difficulty. The organs of animals have, indeed, been dissected and examined from very early times; and more especially, since the revival of learning in Europe. But our acquaintance with the structure of plants is of comparatively modern date; and is necessarily more imperfect, from their organs being less palpable than those of animals in general. In both, however, the obscurity and difficulty of the subject has afforded the usual scope for conjecture. Analogies have been assumed, on the slightest seeming resemblance of functions. Phenomena have been attempted to be explained, by reference to other phenomena imperfectly observed, and therefore imperfectly comprehended in beings possessing little in common but the properties of life and organisation, although in every other respect constituted on a distinct plan. Thus, since the discovery of the circulation of the blood by the acute genius of Harvey, a corresponding circulation of the sap in plants has been, contrary to the principles of just induction, first imagined, and then supported by argument; and an arterial, venous, and lymphatic system of vessels has been, on very slight evidence, attributed to plants. Again, since the clear demonstration of the sexes of plants, by the celebrated Linnæus and his followers, terms have been borrowed from the appendages of the ovum of animals, and applied to those of the seed-vessels of plants, without due proof of the correctness of the analogy, and, therefore, with manifest injury to the unravelling of the truth. But, if it should be argued, that the fact of the existence of a sexual system in plants, is in itself a proof of the justness of such analogy, it may confidently be replied, that the existence of some truth in the analogy from which terms are frequently derived, has been one of the most usual means, first, of the reception, and, eventually, of the establishing of error. Analogy, of itself, is one of the most useful of all monitors in the study of truth: It affords the most important suggestions to the mind; but these must be submitted to the ordeal of experiment, and patient observation, otherwise we shall be perpetually misled. It is not only unsafe, then, to draw conclusions from the laws of the animal economy, and to apply such conclusions to

those of the economy of plants, but it is, in many cases, equally delusive, to apply the deductions of analogy to the distinct races of plants themselves; and yet this source of error is still too prevalent; notwithstanding the meritorious discoveries of Cæsalpinus, Gærtner, R. Brown, Mirbel, and lately of Cassini, in this fundamental part of the physiology of plants. But, surely, because Cæsalpinus discovered, that, in a great number of the seeds of plants, the embryo, forming, in many tribes, the body of the seed, included as between two shallow cups, the still unevolved parts of the future plant; protecting, and, as it were, cherishing them; absorbing moisture from the earth, and, as was long since discovered by Robert Boyle, a portion of the atmosphere*;—certainly neither Cæsalpinus, nor his successors in the present day, have had sufficiently correct grounds for concluding, that another race, including the greater part of the numerous tribes of vascular plants, formed on a distinct plan, in the general structure of their seeds, and even in their minutest germs and manner of growth, as well as in the structure of their stems, in short, every part of their economy, should yet possess in their embryo a *single* monocotyledon, and constitute a class on this very account. It has been concluded, that the Natural Method of arranging plants must stand or fall with the truth of this hypothesis. But, in fact, the natural method has no need of support from the imagination; and, indeed, if it did so, it would deserve to fall. But it is time to come to the point in dispute; and probably the speediest method of ending this or any other controversy is, to appeal to the acknowledged principles of adversaries who, I presume, must admit, that the surest of all characters in deciding precisely the nature of any given organ, whether in plants or animals, is its relative position. Let us try the question of the existence of monocotyledons by this test.

I. The TRUE COTYLEDONS, then, are immediately connected with the trophosperm, and situated, as in the seeds of the numerous tribes of Leguminеæ, EXTERNALLY with respect to all the other organs of the embryo, which they envelope.

The supposed MONOCOTYLEDON of Mirbel and Cassini, on the contrary, is not connected with the trophosperm, and is situated INTERNALLY, with respect to these organs.

* See the late excellent work of Mr Ellis on the Germination of Seeds.

3

2. The REAL COTYLEDONS contain that substance which has (not indeed very appropriately) been termed Albumen by Gærtner, which is destined to nourish and promote the evolution of the infant progeny of the species. Whereas, the supposed MONOCOTYLEDON contains none of this alimentary farinaceous substance, being the mere envelope of one of the germs of the seed; in fact, an abortive sheathing leafet, common to the seminal and cauline germs.

3. Supposing the true COTYLEDONS of the Cruciferæ, for example, were cut off from the remaining parts of the embryo, there would still remain all of the organs which possess any just analogy with those of the embryo of the supposed monocotyledonous tribes.

4. Whilst every one admits the existence and definite position of the true COTYLEDONS, almost every author differs as to the position of the supposed MONOCOTYLEDONS. M. Jussieu applies this term to the scutula or scale, at the base of the seeds of the Gramineæ. Gærtner applies this term to the body of the embryo; whilst Mirbel * and Cassini, in a late number of the Journal de Physique, affix this term to the first enveloping leafet of the germ; but, as I have already shown †, this would entitle every one of the first sheaths of the several germs of the seed to the same designation, which would be ridiculous. The opinion of Linnæus was, that the farinaceous perisperm was the monocotyledon,—an organ totally distinct from the embryo, in the whole of the supposed monocotyledonous tribes.

5. The existence of the monocotyledon being then imaginary, the term MONOCOTYLEDONOUS is false, leads to error, and ought to be laid aside. The term *Endogenæ*, proposed by Decandolle, seems more appropriate; yet even this term must be limited in its application. The great and very natural Family of UMBELLIFERÆ possess real cotyledons, but are not *exogenæ*. I have shown that the filices are *endogenæ*, but still this singular race are totally distinct from all the rest.

* Physiologie vegetale, &c.

† Observations on the Germination of the Gramineæ, *Memoirs of the Wernerian Natural History Society*, vol i.

ART. XIV.—*A Description and Draught of a New Invented Machine, for carrying Vessels or Ships out of or into any Harbour, Port or River, against Wind and Tide, or in a Calm.* By JONATHAN HULLS. With a Plate.

AS the history of the invention of the Steam-boat is but imperfectly known in this country, and still less on the Continent, we have long been desirous of laying before our readers the different documents upon which it is founded.

The great rarity of the pamphlet published at London in 1737, by Jonathan Hulls, has hitherto prevented us from carrying this wish into effect; but we are now able to reprint the portion of it on the steam-boat, from a copy presented to the Library of the Royal Society of Edinburgh, by its distinguished president, Sir Walter Scott.

Mr Hulls's patent, which is prefixed to the pamphlet, was signed on the 21st December 1736. The part of the pamphlet which we have not printed, contains nothing more than a series of elementary propositions in mechanics and pneumatics, which have no greater connexion with the steam-boat than with any other mechanical and pneumatical engine.

" Whereas several persons concerned in the navigation, have desired some account of my invention for carrying ships out of and into harbours, ports and rivers, when they have not a fair wind;

" But I could not fully describe this *machine*, without writing a small treatise of the same, in which I shall endeavour to demonstrate the possibility and probability of the matter undertaken.

" There is one great hardship lies too commonly upon those who propose to advance some new, though useful, scheme for the public benefit: the world abounding more in rash censure than in a candid and unprejudiced estimation of things, if a person does not answer their expectation in every point; instead of friendly treatment for his good intentions, he too often meets with ridicule and contempt.

" But I hope that this will not be my case; but that they will form a judgment of my present undertaking only from trial.

If it should be said, that I have filled this tract with things that are foreign to the matter proposed, I answer, there is nothing in it but what is necessary to be understood by those that desire to know the nature of that machine which I now offer to the world: and I hope, that, through the blessing of God, it may prove serviceable to my country.

"In some convenient part of the tow-boat, there is placed a vessel about two-thirds full of water, with the top close shut. This vessel being kept boiling, rarifies the water into a steam. This steam being conveyed through a large pipe into a cylindrical vessel, and there condensed, makes a vacuum, which causes the weight of the atmosphere to press on this vessel, and so presses down a piston that is fitted into the cylindrical vessel, in the same manner as in Mr *Newcomen's* engine, with which he raises the water by fire.

In Plate VIII. Fig. 1., *P* is the pipe coming from the furnace to the cylinder. *Q* The cylinder wherein the steam is condensed. *R* The valve that stops the steam from coming into the cylinder, whilst the steam within the same is condensed. *S* The pipe to convey the condensing water into the cylinder. *T* A cock to let in the condensing water when the cylinder is full of steam and the valve *p* is shut. *U* A rope fixed to the piston that slides up and down the cylinder. *Note.*—This rope *U*, is the same rope that goes round the wheel *D* in the machine, Fig. 2.

"It hath been already demonstrated, that a vessel of 30 inches diameter, which is but two foot and a-half, when the air is driven out, the atmosphere will press on it to the weight of 4 ton 16 hundred and upwards. When proper instruments for this work are applied to it, it must drive a vessel with a great force.

"*Note.*—The bigness of the machines may be proportioned to the work that is to be performed by them; but if such a force as is applied in this first essay, be not sufficient for any purpose that may be required, there is room to make such addition as will move an immense weight with tolerable swiftness.

"It is my opinion, it will not be found practicable to place the machine here recommended, in the vessel itself that is to be taken in or out of the port, &c. but rather in a separate vessel, for these reasons: 1. This machine may be thought cumbersome,

and to take up too much room in a vessel laden with goods, provisions, &c. 2. If this machine is put in a separate vessel, this vessel may lie at any port, &c. to be ready on all occasions. 3. A vessel of a small burthen will be sufficient to carry the machine to take out a large one. 4. A vessel will serve for this purpose for many years, after she is thrown off, and not safe to be taken far abroad.

" *The Explanation of the Machine.* (See Plate VIII. Fig. 2.)

" *A*, Represents the chimney coming from the furnace.

" *B*, The tow-boat.

" *C C*, Two pieces of timber framed together, to carry the machine.

" *D a*, *D* and *D b*, are three wheels on one axis to receive the ropes, *M F b* and *F a*.

" *H a* and *H b* are two wheels on the same axis with the fans *I I I I I I*, and move alternately in such a manner, that when the wheels *Da*, *D* and *D b* move backward or forward, they keep the fans *I I I I I I* in a direct motion.

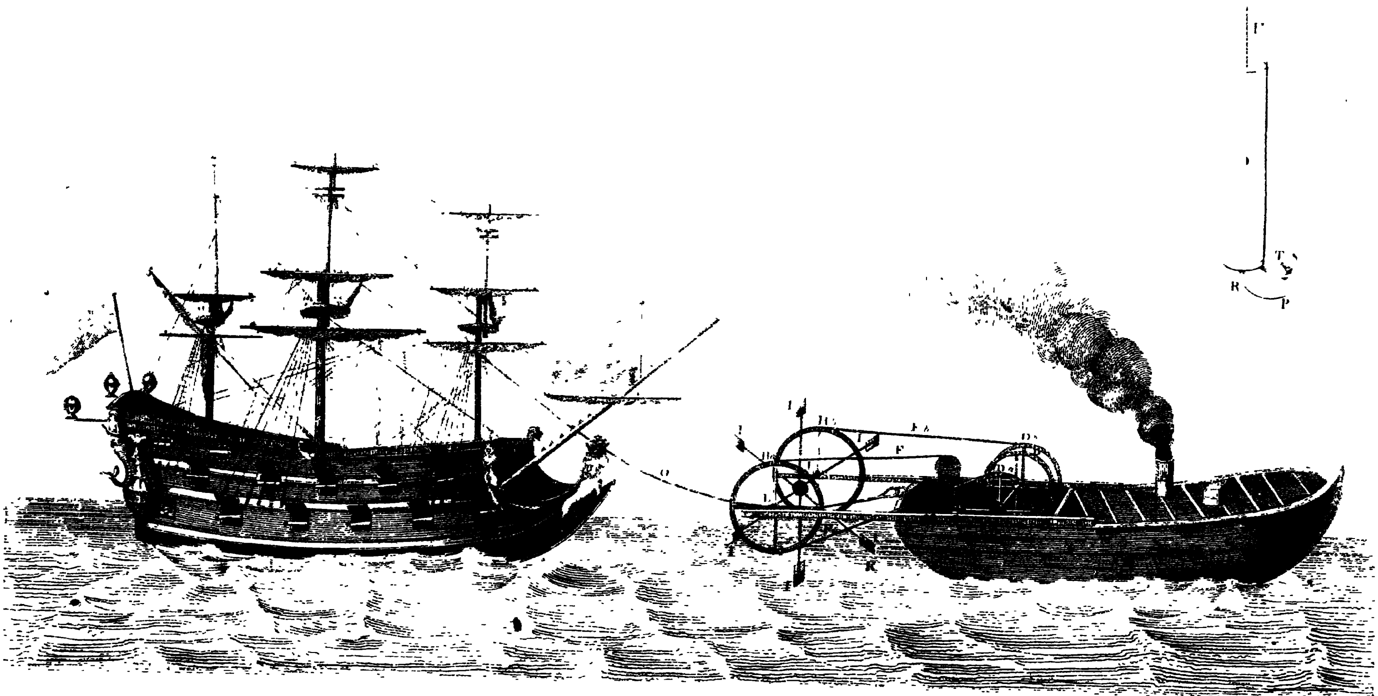
" *F b* is a rope going from *H b* to *D b*, that when the wheels *D a*, *D* and *D b* move forward, moves the wheel *H b* forwards, which brings the fans forward with it.

" *F a* is a rope going from the wheel *H a* to the wheel *D a*, that when the wheels *D a*, *D* and *D b* move forward, the wheel *H a* draws the rope *F*, and raises the weight *G*, at the same time as the wheel *H b* brings the fans forward.

" When the weight *G* is so raised, while the wheels *D a*, *D* and *D b* are moving backward, the rope *F a* gives way, and the power of the weight *G* brings the wheel *H a* forward, and the fans with it, so that the fans always keep going forward, notwithstanding the wheels *Da*, *D* and *D b* move backwards and forwards, as the piston moves up and down in the cylinder.

" *L L*, are teeth for a catch to drop in from the axis, and are so contrived, that they catch in an alternate manner, to cause the fans to move always forward, for the wheel *H a* by the power of the weight *G*, is performing his office, while the other wheel *H b* goes back, in order to fetch another stroke.

" *Note.*—The weight *G* must contain but half the weight of pillar of air pressing on the piston, because the weight *G* is



W H Lizars sc

Published by A Constable & C° Edin^r 1823

raised at the same time as the wheel *H b* performs its office, so that it is in effect two machines, acting alternately by the weight of one pillar of air of such a diameter as the diameter of the *cylinder* is.

"If it should be said that this is not a new invention, because I make use of the same power to drive my machine that others have made use of to drive theirs for other purposes, I answer, The application of this power is no more than the application of any common or known instrument used in mechanism, for new invented purposes.

"*Answers to some Queries that have been made, concerning the Possibility and Usefulness of this Undertaking.*

"*Query* I.—*Is it possible to fix Instruments of sufficient Strength, to move so prodigious a Weight, as may be contained in a very large Vessel?*

"*Answer.*—All mechanics will allow it is possible to make a machine to move an immense weight, if there is force enough to drive the same; for every member must be made in a proportionable strength to the intended work, and properly braced with laces of iron, &c. so that no part can give way or break. If the braces, &c. necessary for this work, had been put in the draught, it would have been so much crowded with lines, that the main instruments could not be so well perceived.

"*Query* II.—*Will not the force of the waves break any instrument to pieces, that is placed to move in the water?*

"*Answer.*—1*st*, It cannot be supposed that this machine will be used in a storm or tempest at sea, when the waves are very raging; for if a merchant lieth in harbour, &c. he would not choose to put out to sea in a storm if it were possible to get out, but rather stay until it abated.

"2*dly*, When the wind comes a-head of the tow-boat, the fans will be protected by it from the violence of the waves; and when the wind comes sideways, the waves will come edgeways of the fans, and therefore strike them with the less force.

"3*dly*, There may be pieces of timber laid to swim on the surface of the water on each side of the fans, and so contrived as they shall not touch them, which will protect them from the force of the waves.

"Up in-land rivers, where the bottom can possible be reached, the fans may be taken out, and cranks placed at the hindmost axis to strike a shaft to the bottom of the river, which will drive the vessel forward with the greater force.

"*Query* III.—*It being a continual expence to keep this machine at work, will the expence be answered?*

"*Answer.*—The work to be done by this machine will be upon particular occasions, when all other means yet found out are wholly insufficient. How often does a merchant wish that his ship were on the ocean, when, if he were there, the wind would serve tolerably well to carry him on his intended voyage, but does not serve, at the same time, to carry him out of the river, &c. he happens to be in, which a few hours' work of this machine would do. Besides, I know engines that are driven by the same power as this is, where materials for the purpose are dearer than in any navigable river in England; therefore, experience demonstrates, that the expence will be but a trifle to the value of the work performed by those sort of machines, which any person that knows the nature of those things may easily calculate.

"Thus, I have endeavoured to give a clear and satisfactory account of my new invented machine, for carrying vessels out of and into any port, harbour or river, against wind and tide, or in a calm; and I doubt not, but whoever shall give himself the trouble to peruse this essay, will be so candid as to excuse or overlook any imperfections in the diction or manner of writing, considering the hand it comes from; if what I have imagined, may only appear as plain to others as it has done to me, viz. that the scheme I now offer is practicable, and, if encouraged, will be useful. J. H."

Art. XV.—*Reflections on Volcanoes.* By M. Gay Lussac.

Before indulging in some reflections upon volcanoes, a wide field which has been long open to conjecture and hypothesis, I must commence with declaring that I am not in possession of the knowledge requisite for treating of such a subject in full, and that I shall only glance at it, confining myself

to certain questions connected with chemistry, and for which it is not requisite to possess all the information necessary to constitute a geologist. The subject is besides a difficult one, and requires indulgence.

Two hypotheses may be formed regarding the cause by which the phenomena of volcanoes are produced. According to one of these, the earth is still in a state of incandescence at a certain depth below its surface, as the observations recently made in mines upon the augmentation of its temperature would lead us to presume; and this heat is the principal cause of volcanic phenomena. According to the other hypothesis, their principal cause is a very energetic affinity between substances, fortuitously brought into contact with each other, and from which results a heat sufficient for melting lavas, and raising them by the pressure of elastic fluids to the surface of the earth.

Both hypotheses have this in common, that the volcanic fires must necessarily be fed by substances which were at first foreign to them, and which are carried to them in some manner or other.

In fact, at those remote periods which have witnessed the great catastrophes of our globe, periods at which its temperature must have been more elevated than at the present day, and the melted matters which it contained consequently more liquid, the resistance of its surface less, and the pressures exercised by the elastic fluids greater, all that could be produced has been done; an equilibrium must have been established, a state of repose which could no longer be interrupted by intestine causes, and which could only be so in our times by new contacts between bodies, which are brought together by accidental causes, and which perhaps have only been added to the mass of the globe posteriorly to the solidification of its surface.

Now, the possibility of bodies finding their way from the surface to the interior of the earth, the ascent of lavas to considerable heights above the surface of the earth, the ejections by explosion, and earthquakes, necessarily require that the foreign substances which penetrate into the volcanic foci be elastic fluids, or rather liquids capable of producing them, either by heat, which reduces them to a state of vapour, or by affinity, which disengages some gaseous elements.

On consulting analogy, we find, that the substances capable

of penetrating into the volcanic foci in masses sufficient for feeding them, are air or water, or both together. Many geologists have given air a great influence in volcanoes: it is, according to them, its oxygen that produces their combustion; but a very simple observation suffices entirely to overthrow this opinion.

How, in fact, could air penetrate into volcanic foci, when there exists, from within outwards, a pressure which is capable of elevating the liquid lava, having a specific gravity of about 3, to a height of more than 1000 metres, as at Vesuvius, and to more than 3000 in a great number of volcanoes? A pressure of 1000 metres of lava, equivalent to a pressure of 3000 metres of water, or to about 300 atmospheres, necessarily excludes all introduction of air into the interior of volcanoes; and as this pressure is kept up for many years, during which the volcanic phenomena nevertheless preserve a great activity, the action of air in producing these phenomena must be absolutely null. It is besides evident, that if the air communicated freely with the foci of volcanoes, the ascent of lava and the phenomena of earthquakes could not take place.

If air cannot be the cause of volcanic phenomena, it is however probable that water is a very important agent in producing them.

That water penetrates into the foci of volcanoes, is a fact that can by no means be called in doubt. There is never a great eruption that is not followed by an enormous quantity of aqueous vapours, which, being afterwards condensed by the cold above the summit of the volcanoes, fall in copious rains, accompanied with frightful thunders, as was observed in the famous eruption of Vesuvius in 1794, which destroyed the *Torre del Greco.* Aqueous vapours and hydrochloric gas have also been often observed in the daily ejections of volcanoes, the formation of which in the interior of volcanoes, it is impossible to conceive without the aid of water.

Admitting that water may be one of the principal agents of volcanoes, there remains to examine the true influence that it may have, in each of the two hypotheses which we have formed, upon the heat of their foci.

Supposing, according to the first hypothesis, that the earth is still in a state of incandescence at a certain depth beneath its

surface, it is impossible to conceive the existence of water at this depth; for the temperature of the earth having been necessarily more elevated at a former period, its fluidity greater, and the thickness of its solid crust smaller than at the present day, the water must, by indispensable consequences, have been disengaged from its interior, and elevated above its surface.

It would therefore be necessary, in order that the hypothesis might retain its probability, and the water its importance as a principal agent of volcanoes, that it penetrated to the incandescent strata of the earth, proceeding from above downwards; but then we must suppose it to have a free communication with these beds, see it gradually heating before arriving there; and ask, how its vapour, pressed, moreover, by its whole liquid column, could have an elastic power sufficiently great to raise lavas, produce earthquakes, and bring about the other phenomena of volcanoes? These difficulties, which might be multiplied, render altogether inadmissible the hypothesis, that the heat of volcanoes is owing to the state of incandescence of the earth at a certain depth below its surface: I say more, this incandescence is entirely hypothetical itself; and, notwithstanding the observations on the increase of temperature in mines, I consider it as very doubtful.

In the second hypothesis which we have offered, that the principal cause of volcanic phenomena is a very energetic affinity between substances, fortuitously brought into contact, it is necessary that the water meet in the interior of the earth, with substances to which it may possess a sufficiently powerful affinity to be decomposed, and give rise to a considerable disengagement of heat.

Now, the lavas ejected by volcanoes being essentially composed of silica, alumina, lime, soda and oxide of iron, bodies all oxidised, and having no longer any action upon water, it is not in this state that they must have originally existed in volcanoes; and from what we now know of their true nature, since the beautiful discoveries of Sir Humphry Davy, they must have occurred, if not all, at least a great part of them, in the metallic state. We then readily conceive that, by their contact with water, they might decompose it, be changed into lava, and produce a sufficiency of heat to explain the greater number

of volcanic phenomena. But as my object is not to fabricate a system, but, on the contrary, to examine the probability of the two hypotheses which I have mentioned, and to point out the observations which may be made upon volcanoes, I shall now state the results of the latter hypothesis.

One, the most important perhaps, of these consequences, is the disengagement, by the crater of volcanoes, of an enormous quantity of hydrogen, either free, or combined with some other principle, if it be really water which produces, by its oxygen, the volcanic fires. However, it does not appear that the disengagement of hydrogen is of very frequent occurrence in volcanoes. Although, during my stay at Naples in 1805, with my friends MM. Alexander de Humboldt and Leopold de Buch, I witnessed at Vesuvius frequent explosions, which threw the melted lava to a height of more than 200 metres, I never observed any inflammation of hydrogen. Each explosion was followed by vortices of a dense and black smoke, which would not have failed to have been inflamed, had they been formed of hydrogen, being traversed by red matters hotter than would have been necessary for their ignition. This smoke, evidently caused by the explosions, contained, therefore, other fluids than hydrogen; but what was its true nature?

In admitting that it is water which furnishes oxygen to volcanoes, it follows, since its hydrogen is not disengaged in a free state, at least most commonly, that it enters into a state of combination. It cannot be in any compound which inflames by means of heat on exposure to air; but it might very well be the case that it forms with chlorine the hydrochloric acid.

We have in fact at the present day many observations on the presence of this acid in the vapours of Vesuvius; and according to that excellent observer M. Breislak, it is at least equally abundant with sulphurous acid. M. Menard de la Groye, whose rash ideas regarding volcanoes I am in other respects far from being disposed to adopt, and M. Monticelli, to whom we are indebted for accurate observations on Vesuvius, also consider the presence of hydrochloric acid in the vapours of Vesuvius as incontestible. For my own part, I retain no doubt on the subject, although, during my stay at Vesuvius, I only distinguished by smell sulphurous acid; but it might be very possible that the foreign sub-

stances mixed with the hydrochloric acid should make its smell be mistaken. It would be desirable that M. Monticelli, who is so well situated for studying Vesuvius, would place water containing a little potash, in open vessels, in several places of that volcano. This water would become gradually charged with acid vapours, and, at the end of some time, it would be easy to determine their nature.

If the hydrogen furnished by water to combustible substances in the volcanic foci entered entirely into combination with the chlorine, the quantity of hydrochloric acid disengaged by volcanoes would be enormous. It would therefore be matter of surprise, that this acid had not been oftener observed.

Further, it would be necessary that the metals of the silica, alumina, lime, and oxide of iron, were combined with the chlorine; and in order to explain the high temperature of volcanoes, we must still suppose that the contact of the chlorates of silicium and aluminum with water, produced a great disengagement of heat. Such a supposition is not altogether improbable; but admitting it, we still want data for making a satisfactory application of it to volcanic phenomena.

If the combustible metals are not in the state of chlorides, the hydrochloric acid is then a secondary result; it is produced by the action of the air on some chlorate, (probably that of sodium); an action which is favoured by the mutual affinity of oxides. M. Thenard and myself have shown, that when muriat of soda and sand, both of them perfectly dry, are heated to a red heat, no hydrochloric acid is disengaged; but if the vapour of water be made to pass over a mixture of sand or clay with muriate of soda, the hydrochloric acid is immediately disengaged in very great abundance.

Now, the production of this acid, by the meeting of water and of some oxide with a chloride, must be very frequent in volcanoes. Lavas contain chlorides, since they exhale the acid abundantly on being exposed to the air. MM. Monticelli and Covelli obtained, by simple washing in boiling water, more than 9 per cent. of muriate of soda, from the lava of Vesuvius of 1822. It is exhaled also by the mouth of volcanoes, for we see very beautiful crystals of it in the scoriæ which cover the incandescent lava. If, consequently, these lavas are placed in con-

tact with water, either in the interior of the volcano, or at the surface of the earth, by means of air, it must necessarily be produced from the hydrochloric acid. MM. Monticelli and Covelli have in fact observed the production of acid vapours in crevices nearly incandescent; but they took them for sulphuric acid, although I am convinced that they were essentially formed of hydrochloric acid. There is the more reason for calling their observations in doubt, that they have often been very uncertain regarding the nature of acid vapours, whether they were sulphureous or muriatic.

It is known that lavas, especially those which are spongy, contain much specular iron-ore. In 1805, in a gallery formed in Vesuvius by the lava of the preceding year, which, after having cooled at its surface, had gradually contracted below, I saw, in company with MM. de Humboldt and de Buch, so great a quantity of it, that it formed as it were a vein. It covered, in beautiful micaceous crystals, all the walls of this gallery, the temperature of which was still too great to allow one to remain long in it. Now, the peroxide of iron being very fixed at temperatures much higher than that of lava, it is by no means probable that it had been volatilized in that state; it is very probable that originally it had been in the state of a chloride.

If, in fact, we take protochloride of iron, which has been melted, expose it to a dull red heat in a glass tube, and then make a current of aqueous vapour pass over its surface, we shall obtain a great quantity of hydrochloric acid and hydrogen gas, and there will remain in the tube a black deutoxide of iron. On employing dry oxygen in place of aqueous vapour, we obtain chlorine and peroxide of iron. The experiment is easily made by mixing the chloride of iron with dry chlorate of potash; on the slightest heat being applied, the chloride is disengaged abundantly. If we make humid air pass over the chloride, always at a temperature approaching to red, we obtain chlorine, hydrochloric acid, and peroxide of iron.

The perchloride of iron exhibits similar phenomena. If it meet with humidity, we presently obtain hydrochloric acid, or rather chlorine, if it meet with oxygen; and it is formed from the peroxide of iron. I conceive, therefore, that the iron is in the state of a chloride in the fumes exhaled by volcanoes, or by

their lavas, on coming in contact with the air, and that by means of the heat, water and oxygen of the air, it is changed into a peroxide, which aggregates and assumes a crystalline form, on being precipitated.

On bringing chlorine in contact with an iron wire, at the temperature of about 400°, the iron becomes presently incandescent; but not nearly so much so as with oxygen. The perchloride is very volatile; it crystallizes by cooling in small delicate spangles, which, in the air, are almost instantly dissolved by deliquescence. It becomes so hot when brought into contact with water, that I should not be surprised if, when in a great mass, and with a corresponding quantity of water, it should become incandescent. I make this observation to show, that if the silicium and aluminum were really in the state of a chloride in the bowels of the earth, they might produce a much higher temperature, on coming in contact with water, since their affinity for oxygen is much greater than that of iron.

If it be disengaged from the sulphurous acid of volcanoes, as there can be no doubt it is, it is very difficult to form an opinion regarding its true origin. Whence does it obtain the oxygen necessary for its formation, unless it be the result of the decomposition of some sulphates by the action of heat, and of the affinity of their base for the other bodies? This is what appears to me to be the most probable opinion; for I cannot imagine, that sulphur, from its known properties, is an agent in producing volcanic fires.

Klaproth and Vauquelin have conjectured that basalts might owe their colour to carbon; but, to overthrow this conjecture, it is sufficient to remark, that, when a mineral which is fusible, and contains even less than 10 hundredth parts of oxide of iron, is heated strongly in a crucible, much of the iron is reduced, as Klaproth has shewn in the first volume of his *Essays.* Further, according to MM. Gueniveau and Berthier, there does not remain more than from 3 to 4 per cent of oxide of iron in the scoriæ of furnaces. Now, as lavas contain much iron, and the basalts that have been analysed contain from 15 to 25 per cent. of it, it is not probable that carbon could remain together with so great a quantity of iron, without reducing it.

Is it possible that metallic iron, if disengaged from the hydro-

gen of volcanoes, should occur in lavas, since hydrogen has the property of reducing its oxides at a high temperature? It is certain, at least, that the iron does not occur in the state of a peroxide; for they act powerfully on the magnetic needle, and the iron appears to be precisely at the degree of oxidation which the water alone determines; that is to say, in the state of a deut-oxide. Further, to prevent the hydrogen from reducing the oxides of iron, it would be sufficient, as I have shewn, that it were mixed with several times its volume of aqueous vapour.

The necessity, as appears to me, of water penetrating into the foci of volcanoes, the presence, in lavas, of some hundred parts of soda, that of muriate of soda, and of several other chlorides, render it very probable that it is the water of the sea which most commonly penetrates. But an objection occurs which I must not pass over: it is this, that the lava ought to make its egress by the canals through which the water has entered, since it would find in them a less resistance than in those by which it is raised above the surface of the earth. It should, in this case, also frequently happen, that the elastic fluids formed in the foci of volcanoes, previous to the ascent of the lava to the surface of the earth, should boil forth by the same canals in some places of the surface of the sea,—a circumstance which I am not aware of having been yet observed, although it is probable that it is these elastic fluids which produce the mephitic gases so common in volcanic countries.

On the other hand, it might be remarked, that the long intermissions of volcanoes, and their state of repose during a great number of years, seem to shew that their fires are extinguished, or at least smothered; then the water would gradually penetrate, by its pressure, into imperceptible fissures, to great depths in the interior of the earth, and would accumulate in the vast cavities which it contains. The volcanic fires would gradually kindle again; and the lava, after having obstructed the canals by which the water penetrated, would be raised by its usual orifice, the diameter of which would increase continually by the fusion of its walls. These are merely conjectures; but it is pretty certain that water actually exists in the foci of volcanoes.

We see how the theory of volcanoes is still uncertain. While we have strong reasons to think that the earth contains sub-

stances highly combustible, we still want precise observations to enable us to appreciate their action in volcanic phenomena. It would be necessary to know the nature of the vapours exhaled by several volcanoes; for the cause which produces their activity being assuredly the same, the product, which would be common to all, might throw light upon it. All the other products would be accidental; that is to say, they would be owing to the action of heat upon the inert matters toward which the volcanic focus might extend.

The great number of burning volcanoes diffused over the surface of the earth, and the still greater number of mineral masses which bear evident marks of their ancient volcanic origin, should, in a general point of view, make us consider the bounding stratum of the earth as a crust of scoriæ, beneath which there exist a great number of foci, of which some are extinct, while the others are in a state of ignition. And, what is well calculated to surprise us is, that the earth, so many ages old, still preserves an intestine power which raises mountains, overthrows cities, and agitates the whole mass.

The greater number of mountains, on issuing from the bowels of the earth, must have left vast cavities, which have remained empty, at least they have not been filled with water. But it was in a very erroneous way that Deluc, and many other geologists, made use of those empty spaces which they imagined to be prolonged in the form of long galleries, for propagating earthquakes to a distance.

An earthquake, as Dr Young has very properly observed, is analogous to an undulation in the air. It is a very strong sonorous wave, excited in the solid mass of the earth, by an agitation which is propagated with the same celerity as sound. What is surprising in this great and terrible phenomenon of nature, is the immense extent to which it is felt, the ravages which it produces, and the power of the cause which excites it. But sufficient attention has not yet been paid to the facility with which all the parts of a solid mass are shaken. The shock produced by the head of a pin, at one of the ends of a long beam, makes all its fibres vibrate, and is distinctly transmitted to the other end. The movement of a carriage on the street, shakes the largest buildings, and is communicated across considerable

masses, as in the deep quarries beneath Paris. Why, then, should it surprise us, if a very violent commotion in the bowels of the earth make it shake in a radius of several hundreds of leagues? In a word, earthquakes are only the propagation of a commotion across the mass of the earth, so much independent of subterraneous cavities, that it extends so much the farther that the earth is more homogeneous *.

ART. XVI.—*On the Refractive and Dispersive Power of different Species of Glass, in reference to the improvement of Achromatic Telescopes, with an Account of the Lines or Streaks which cross the Spectrum* *. By JOSEPH FRAUENHOFER of Munich. With a Plate.

THE calculation of an Achromatic Object-Glass, and, in general, that of every achromatic telescope, requires a precise knowledge of the ratio of the Sines of incidence and refraction, and of the ratio of dispersion of the different kinds of glass which are used in the composition of telescopes. The methods hitherto employed for finding these ratios, have given results differing considerably from each other, in spite of the care and accuracy employed in the computation. We ought, therefore, to expect inaccuracies which render the perfection of the object-glass doubtful. Experiments repeated during many years have led me to discover new methods of obtaining these ratios; and I have therefore obeyed the wishes of several philosophers in publishing these experiments, in the same order in which I made them, and with the modifications which the experiments themselves obliged me to introduce.

I began by determining the dispersion of a single kind of glass, from the size of the prismatic spectrum, formed by a prism of a given angle in a dark chamber, and at a given distance, and from this I deduced the dispersion. The ends of the spectrum, however, were ill terminated, and a considerable uncertainty was attached to the results.

---

* Translated from the *Annales de Chimie et Physique*, t. xxii. April 1823.

† Translated from the French in Shumacher's *Astronomische Abhandlungen*, zweites Heft, p. 13. Altona, 1823.

Fig. 5

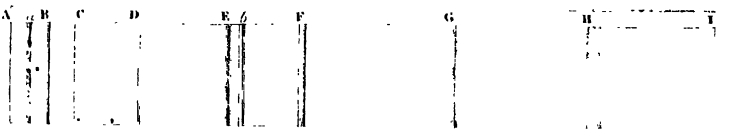


Fig. 1

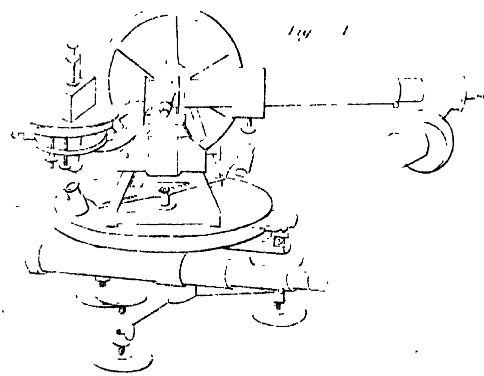


Fig. 3

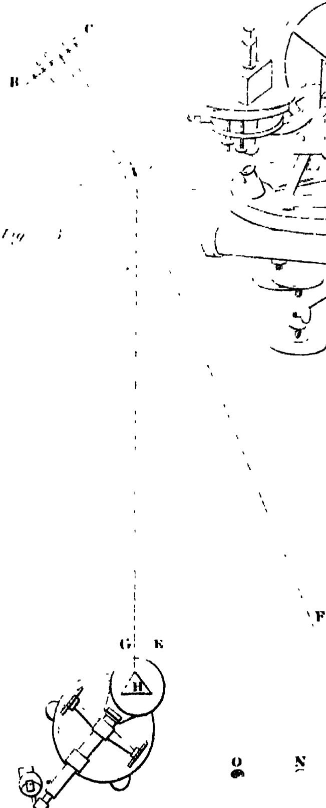


Fig. 2

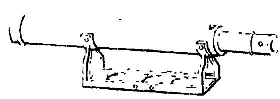
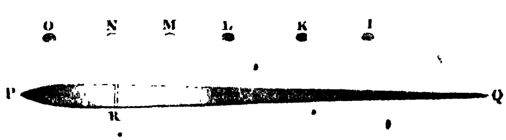


Fig. 4



Published by A. Constable & Co. Edinr. 1823

Lizars Sculpt

In order to determine the ratio of the refraction and dispersion of flint and crown glass, I made use of prisms of these two kinds of glass, having their respective angles small, and placed in opposite directions. These last were then successively changed, till, on the one hand, the refrangibility, and, on the other, the refraction, was nothing. The ratio of the angles was then the inverse ratio of that of the refrangibility or the refraction. Several prisms, however, thus put together in pairs gave different results, particularly for the dispersion. Hence, in order to determine the relative dispersion, I select larger prisms, having their refracting angles also greater, and placed in opposite directions. The prism of crown-glass had an angle of from 60° to 70°. The angle of one of the prisms was changed till the dispersion was almost destroyed; and the little that remained was then corrected, by changing the angle of incidence of the ray. Since in prisms with great angles, the light is totally reflected at the second surface, even by a small variation of the angle of incidence, I covered the two touching faces of the prisms with a strong refracting fluid, such as oil, and by this means the light was transmitted at almost all angles of incidence. I applied the two prisms before the object-glass of the telescope, and a repeating theodolite, having placed them upon a horizontal plane, with a steel axis, round which it moved. The box in which the axis turned was firmly united with the telescope, as shewn in Fig. 1. of Plate VII. By this procedure I was enabled to measure exactly the angle of incidence at which the dispersion was destroyed. I first looked through the telescope across the prism, at a distant object, having its edges vertical and very distinct; I then changed the angle of incidence, by turning the plane upon which the prisms rested, and the alidade of the theodolite, till the dispersion appeared to be very small, or rather till the vertical edges of the object were most distinct. In order to measure the angle of incidence, I had put upon the turning plane a ruler, which carried two steel points, that exactly touched the first surface of the prisms. On this ruler was fixed a telescope, a little elevated, whose axis was perfectly parallel to the two points of steel; see Fig. 2. This telescope was fixed upon the ruler only by its two ends, so that through the interstice between the telescope and the ruler the light could

freely fall upon the prisms. Hence it was easy to measure in this manner, by the theodolite, the angle of incidence. Knowing, therefore, this angle, and also the index of refraction, and the angles of the prisms, which can be obtained exactly by the same ruler of the theodolite, the ratio of dispersion could then be deduced by a very exact expression*.

The observations made with two similar prisms agreed so well, that in an object-glass calculated after these data, there was no injurious aberration of colour. But if, in determining the relative dispersion, we employ different pairs of prisms, formed of the same kind of glass, and having their angles different, the results present differences which might leave an uncorrected aberration injurious to object-glasses of considerable dimensions. This result conducted me to the following experiments.

If we look at an object across two prisms of flint and crown glass, with their refracting angles in opposite directions, particularly with a telescope, it will never appear without colour. At a certain angle of the incident rays, the dispersion is a minimum, and, either by increasing or diminishing this angle, the dispersion increases. The remaining dispersion arises, as is well known, from the different prismatic colours having a different ratio of dispersion in the two kinds of glass. If, in crown-glass, for example, the dispersion of the red rays is to that of the same rays in flint-glass as 10 to 19, then the violet rays may be dispersed in the ratio of 10 to 21. Hence, the two dispersions can never entirely compensate one another.

It would be of great importance to determine for every species of glass the dispersion of each separately coloured ray: But, since the different colours of the spectrum do not present any precise limits, the spectrum cannot be used for this purpose. More precision would be obtained, if we possessed glasses or coloured fluids which permitted only light of the same colour to pass; the one, for example, permitting only the blue light to pass, and the other only the red. I have not been fortunate enough, however, to procure either a glass or a fluid which possessed this property. In every case, the white light which pass-

* The method of examining the dispersion of two prisms through a telescope was first proposed and used by Dr Brewster in 1812. See *Treatise on New Philosophical Instruments*, p. 300.—Transl.

ed through was still decomposed into all its colours, with this difference only, that in the spectrum, the colour peculiar to the glass or the fluid was more brilliant than the rest. Even the coloured flames obtained by burning alcohol, sulphur, &c., seen through a prism, do not yield a homogeneous light corresponding to the colour *. These flames, however, such as that of a lamp, particularly that of a candle, and, in general, the light produced by the flame of a fire, exhibit between the red and yellow of the spectrum a clear and well marked line, which occupies the same place in all the spectra. This line will become more important in the sequel, and it was one of great utility to me. It appears to be formed by rays which are not decomposed by the prism, and which consequently are homogeneous. In the green space we perceive a similar line, but it is weaker, and less distinct, so that it is often very difficult to find.

It was, however, absolutely necessary for me to have homogeneous light of each colour, and the following was the method which I employed. Behind an aperture in a shutter, 1.5 of an inch high and 0.07 wide, I placed a prism A (Fig. 3. of Plate VII.) of flint-glass, with an angle of about 40°, and at BC, a distance of about 13 feet, I placed six lamps, whose light fell through narrow apertures on the prism A. The width of these apertures was 0.05 of an inch, their height nearly 1.5, and the distance of one lamp from another 0.58. The light of the lamps which fell on the prism A was refracted by it, and decomposed into colours, and afterwards passed through the aperture in the shutter. From the lamp C, for example, the red rays came in the direction of E, and the violet in that of D. From the lamp B the red rays passed towards F, and the violet rays towards G, &c. At the window of another house, 692 feet from A, and at the same height of the plane BAC, I placed the theodolite already mentioned, before the telescope of which, on the horizontal plane, was set the prism H, whose index of refraction for the different coloured rays I wished to determine. The prism H could only receive from the lamp C the red rays,

* For an account of various recent experiments on this subject, made by Dr Brewster and Mr Herschel, see the *Edinburgh Transactions*, Vol. IX. p. 433. and 445.—Transl.

the others, for example, the violet, going to a side at D, did not fall upon the prism. In like manner, from the lamp B, it was only the violet rays which fell upon the prism H. In this way, the prism received from each lamp rays of a different colour, setting out from the same point. If the prism H, or the aperture of the object-glass, was not too broad, some rays of the six lamps, for example, those between the violet and the blue, between the blue and the green, &c. will not fall upon the prism H, but will be entirely wanting. In this case, the spectrum of rays passing by the small aperture A, and seen by the prism H, and by the telescope of the theodolite, will appear as in Fig. 4., where I is the *violet*, K the *blue*, L the *green*, &c., and each colour will appear separate. The distances ON, NM, &c. will increase as the dispersive power of the glass with the same angle of the prism H is greater. Since these distances, and the angle formed by the incident ray with an emergent ray, may be measured by the theodolite with a great degree of accuracy, it is easy, by means of this mechanism, to determine the index of refraction of each coloured ray for every kind of refracting substance. Above the prism A, at the distance of 1½ feet, I made in the shutter another aperture, in the same vertical line with A, behind which I placed a lamp, from which the prism H likewise received light. The spectrum produced by the lamp ought then to appear by the prism before the telescope of the theodolite, and below the coloured points as P,R,Q. The shining orange or reddish line which appears in every spectrum of the light of the fire is shewn at R. This line enables us, in the present case, to be certain, that, on different days of observation, we have always the same colour in the coloured points, which would not take place if the table on which the lamps are placed suffer the least change in relation to the prism. On this account, we ought to place the table so that the point N may be always found in the same vertical line with R. When this is not the case, it is easy to bring it to the position by the adjusting screws B and C. Since the distance of the lamps, or rather that of the small apertures by which the light falls on the prism A is invariable, we are sure, on different days of observation, to have always the same colour in the coloured points.

The distances of some of these coloured points, for example the violets, the blues and the reds, whose light is weak, cannot be measured without illuminating the micrometer wires of the telescope. These coloured points, however, lose, by the ordinary method of illuminating the field, as much light as the wires receive, and therefore this method cannot be employed. It was necessary therefore to have a mechanism by which the wires alone could be illuminated, while the rest of the field remained dark. Such a mechanism I applied to my micrometer. The illuminating of the wires may thus be modified at pleasure, and always with facility. This is effected on the side of the eye-glass by means of a small lamp inclosed in a hollow globe, from which the light falls upon a lens, and throws it in a parallel manner on the wires. At the inner margin of the eye-glass, constructed for the purpose, the rest of the incident light is absorbed without falling on the lens.

With this apparatus I have measured the angles of refraction of the different coloured rays for several refracting substances, the results of which are given in the following Table. With all the substances, the angle of the incident ray is equal to the angle of the emergent ray N. Each angle was measured four times. Since the light which sets out from A does not fall in a parallel manner on the prism H; or rather, since the plane in which the prism H is placed is not in the axis of the theodolite, but at its centre is distant from the axis 4.25 inches, it was necessary to apply a small correction to the angle that the incident ray makes with the emergent ray N. The distance of A from H being 692 feet, the correction for the prism of flint-glass is + 31″, for that of crown-glas + 40″, and for water 40″, &c. The angles LM, NM, &c. do not require this correction.

Refracting Media.	Temp. Reaumur.	Specific Gravity.	Angle of the Prism.	Angle of Deviation, or of N.	See Plate VII. Fig. 4.				
					ON	NM	NL	NK	NI
			° ′ ″	° ′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
Crown gl. No. 9.	3	2.535	39 20 35	22 38 20	6 1	5 43	11 22	16 56	22 16
Flint gl. No. 13.	5½	3.723	26 24 30	17 27 9	7 17	7 15	14 18	21 31	28 46
Water,	8	1.000	58 5 10	22 36 41	6 35	6 19	12 9	17 45	23 18
Water,	9¼	1.000	58 5 40	22 36 43	6 30	6 12	12 5	17 43	23 10
Sulphuric Acid,	9½	1.841	58 5 40	29 27 47	7 50	7 15	14 3	20 30	26 45
Alcohol,	9	0.809	58 5 40	25 8 32	6 35	6 17	12 55	18 45	
Vitriolic Ether,	9		58 5 40	24 38 39	6 20	6 27	12 55	19 10	
Sulphuric Ether,	9		58 5 40	24 38 39	6 20	6 27	12 55	19 10	
Oil of Turpentine,	7	0.885	58 5 40	33 22 8	11 00	11 35	22 45	34 20	
Kali dissolved in water,	8¼	1.416	58 5 40	27 45 51	8 32	7 58	15 35	23 6	30 24
1 part Sugar of Lead, 3 parts Water,	8½		58 5 10	24 34 19	7 51	7 31	14 47	21 40	28 22
Oil of Turpentine,	8¼	0.885	58 5 40	33 20 8	11 5	11 32	22 45	33 56	14 50

In the following table I have given the indices of refraction for the different coloured rays in flint-glass, crown-glass, and water, which have been computed from the observed angles, calling O *n* the index of refraction for the ray O, and N *n* that for the ray N, &c.

Refracting Media.	O *n*	N *n*	M *n*	L *n*	K *n*	I *n*
Flint-glass, No. 13.	1.63074	1.63505	1.63933	1.64349	1.64775	1.65203
Crown-glass, No. 9.	1.52736	1.52959	1.53173	1.53380	1.53586	1.53783
Water,	1.33209	1.33359	1.33501	1.33635	1.33763	1.33888

From these data there results the ratio of the dispersion of the different coloured rays for these refracting media, as is shewn in the following table, where O*n*′, N*n*′, &c. are the indices of refraction from the substances that have the strongest dispersion.

Refracting Media.	$\frac{Nn'-On'}{Nn-On}$	$\frac{Mn'-Nn'}{Mn-Nn}$	$\frac{Ln'-Mn'}{Ln-Mn}$	$\frac{Kn'-Ln'}{Kn-Ln}$	$\frac{In'-Kn}{In-Kn}$
Flint-glass, No. 139. Crown-glass, No. 9.	1,93	2,00	2,01	2,07	2,17
Flint-glass, No. 139. Water,	2,87	3,01	3,10	3,33	3,42
Crown-glass, No. 93. Water,	1,49	1,51	1,55	1,61	1,58

From these results, it is obvious that there are great anomalies in the ratio of the dispersion of the differently coloured rays in some refracting media.

These experiments led me to make some observations on the influence of heat upon the refraction of fluids. By the least change of temperature, the refraction of all fluids becomes stronger in the lower part of the prismatic vessel, than it is in the upper part; and hence every fluid acquires a kind of undulation, which prevents the coloured points of the spectrum from being precisely distinguished. In making these experiments during the night, when the temperature continually changes, I was obliged to stir the fluid every five or ten minutes, in order to render it homogeneous. These differences are not great in water, but in other fluids they are so considerable, that all the spectrum is dispersed and confounded, even if the vessel is shut up from the air. Hence it follows that we ought not to expect good object-glasses by substituting fluids in place of flint-glass *. We see also from these experiments, how difficult it must be to melt flint and crown glass of a perfect homogeneity, since in every furnace of a glass-house the heat of the upper part of the crucible is almost one-third stronger than that of the lower part.

In order to obtain the indices of refraction of the differently coloured rays with more exactness, and in order to determine if the action which refracting substances exert upon the light of the sun is the same as upon artificial light, I adopted the following method.

* This inference is surely unfounded; for the small quantity of fluid in an object-glass will soon acquire an uniform temperature. Besides this, Dr Blair has actually made better object-glasses with fluids, than ever were made with flint-glass.—Transl.

Into a dark room, and through a narrow vertical aperture in the window-shutter, about 15″ broad, and 36″ high, I introduced the rays of the sun upon a prism of flint-glass placed upon the theodolite. This instrument was 24 feet from the window, and the angle of the prism was nearly 60°. The prism was placed before the object-glass of the telescope, so that the angles of incidence and emergence were equal. In looking at this spectrum for the bright line, which I had discovered in a spectrum of artificial light, I discovered, instead of this line, an *infinite number of vertical lines of different thicknesses*. These lines are darker than the rest of the spectrum, and some of them appear entirely black. When the prism was turned, so that the angle of incidence increased, these lines disappeared; and the same thing happened when the angle was diminished. If the telescope was considerably shortened, these lines re-appeared at a greater angle of incidence; and at a smaller angle of incidence, the eye-glass required to be pulled much farther out, in order to perceive the lines. If the eye-glass had the position proper for seeing distinctly the lines in the red space, it was necessary to push it in to see the lines in the violet space. If the aperture by which the rays entered was enlarged, the finest lines were not easily seen, and they disappeared entirely when the aperture was about 40″. If it exceeded a minute, the largest lines could scarcely be seen. The distances of these lines and their relative proportions suffered no change, either by changing the aperture in the shutter, or varying the distance of the theodolite. The refracting medium of which the prism is made, and the size of its angle, did not prevent the lines from being always seen. They only became stronger or weaker, and were consequently more or less easily distinguished in proportion to the size of the spectrum. The proportion even of these lines to one another appeared to be the same for all refracting substances; so that one line is found only in the blue, another only in the red, and hence it is easy to recognise those which we are observing. The spectrum formed by the ordinary and extraordinary pencils of calcareous spar exhibit the same lines. The strongest lines do not bound the different colours of the spectrum, for the same colour is almost always found on both sides of a line, and the transition from one colour to another is scarcely sensible.

Fig. 5.* shews the spectrum with the lines such as they are actually observed. It is, however, impossible to express on this scale all the lines and the modifications of their size. At the point A the *red* nearly terminates, and the *violet* at I. On either side we cannot define with certainty the limits of these colours, which, however, appear more distinctly in the red than in the violet. If the light of an illuminated cloud falls through the aperture on the prism, the spectrum appears to be bounded on one side between G and H, and on the other at B. The light of the sun, too, of great intensity, and reflected by a heliostate, lengthens the spectrum almost *one-half.* In order, however, to observe this great elongation, the light between C and G must not reach the eye, because the impression of that which comes from the extremities of the spectrum is so weak as to be extinguished by that of the middle of the spectrum. At A, we observe distinctly a well-defined line. This, however, is not the boundary of the *red*, which still extends beyond it. At *a*, there is a mass of lines, forming together a band darker than the adjacent parts. The line at B is very distinct, and of a considerable thickness. From C to D may be reckoned 9 very delicate and well-defined lines. The line at C is broad, and black like D. Between C and D are found nearly 30 very fine lines, which, however, with the exception of 2, cannot be perceived but with a high magnifying power, and with prisms of great dispersion; they are besides well-defined. The same is the case with the lines between B and C. The line D consists of two strong lines, separated by a bright one. Between D and E we recognise about 84 lines of different sizes. That at E consists of several lines, of which the middle one is the strongest. From E to *b* there are nearly 24 lines. At *b* there are three very strong ones, two of which are separated by a fine and clear line. They are among the strongest in the spectrum. The space *b* F contains nearly 52 lines, of which F is very strong. Between F and G there are about 185 lines of different sizes. At G many lines are accumulated, several of which are remarkable for their size. From G to H there are nearly 190 different lines. The two

* We have reduced this figure greatly, and inserted only a few of the most prominent lines.

bands at H are of a very singular nature. They are both nearly equal, and are formed of several lines, in the middle of which there is one very strong and deep. From H to I they likewise occur in great numbers. Hence it follows that in the space B H there are 574 lines, the strongest of which are shewn in the figure. The relative distances of the strongest lines were measured with the theodolite, and placed in the figure from observation. The faintest lines only were inserted from estimation by the eye.

Various experiments and changes to which I have submitted these lines, convince me that they have their origin in the nature of the light of the sun, and that they cannot be attributed to illusion, to aberration, or any other secondary cause. In transmitting the light of a lamp through the same aperture, we observe only the line shewn at R, in Fig. 4. It occupies, however, exactly the same place as D in Fig. 5; so that the index of refraction of the line D is the same as that of R.

It is easy to understand why the lines are not well marked, and why they disappear, if the aperture of the window becomes too large. The largest lines occupy nearly a space of from 5″ to 10″. If the aperture is not such that the light which passes through it cannot be regarded as a single ray, or if the angle of the width of the aperture is greater than that of the width of the line, then the image of the same line will be projected several times parallel to itself, and will consequently become indistinct, and disappear when the aperture is too great. The reason why, in turning the prisms, we cease to see the lines, unless the telescope is lengthened or shortened, may be thus explained.

The emersion of the rays, in respect to their divergence, is similar to their immersion only in the case where the angles of incidence and emergence are equal. If the first angle is greater, the rays after refraction will diverge, as it were, from a more distant point, and, if it is smaller, from a nearer point. The reason of this is, that the path of the rays which pass nearer the vertex of the prism is shorter than that of those which pass at a greater distance from the vertex. Hence the angles of the refracted rays are not changed, but the sides of the triangles for the emergent rays ought to be in the one case greater, and in the other smaller. This difference ought to vanish if the rays

fall in parallel directions on the prism, which is also proved by experiment. As the violet rays have by the object-glass of the telescope, though achromatic, a focal distance a little shorter than the red rays, we see clearly why it is necessary to displace the eye-glass, in order to perceive the lines distinctly in the different colours.

As the lines of the spectrum are extremely narrow, the apparatus must be very perfect, in order to avoid all aberration, by which the lines may be rendered indistinct, and even dispersed. The sides of the prism ought consequently to be perfectly plain, and the glass of which the prisms are made ought to have neither scratches nor striæ. With English flint-glass, which is never entirely free of these striæ, we can only see the strongest lines. Common glass, and even the English crown-glass, contains many striæ, though they are not always visible to the eye. Those who cannot procure a perfect prism of flint-glass, should use a fluid of great dispersive power, such as oil of anise-seeds, in order to see all the lines. In this case, the prismatic vessel ought to have its sides perfectly plane and parallel. In general, the sides of all the prisms should form an angle of 90° with their base, and this base ought to be placed horizontally before the telescope, if the axis of the telescope is horizontal. The narrow aperture by which the light passes ought to be exactly vertical. The reason why the lines become indistinct, if any of the conditions now mentioned is neglected, may now be readily understood.

(*To be continued.*)

Art. XVII.—*Description of Vettie's Giel, a Scene in Bergen-Stift, in Norway.* By the Rev. U. F. Borgesen *.

I had often heard of this remarkable Giel †, the only passage to a farm, considerable especially for the number of cattle reared on it. From the danger and the difficulty of the way, no clergyman or other official person had ever visited it. What seems

---

* Read before the Wernerian Natural History Society, 31st May 1823.

† A *Giel*, in Norwegian, means a narrow glen with steep precipices on both sides, the space between filled up by a river. Vettie's Giel is several Norwegian miles in length.

more remarkable, not even the oldest peasant in Farnæs (the nearest district to it) had ever been on the farm of Vettie. Men lived and died in close neighbourhood to it without having ever seen it. Nobody ever repaired thither but those who were the nearest relations of the family who lived on it, who of course were in the most isolated situation possible in an inhabited country. My curiosity was much excited. Besides, in order to have a more accurate knowledge of the people and the district, I had made a point to allow no corner of my parish to remain unvisited. The danger itself was a sort of allurement, as it was a triumph to surmount it.

On Sunday the 12th of June 1818, after divine service, I set out from my manse in Aardalannex, in company with a number of people who had been at church, to Aardal's Water. This lake is about three-quarters of a mile long (more than four English miles), and at the broadest half a quarter (about three-quarters of an English mile), inclosed on both sides by lofty mountains, which, from their steep and sometimes perpendicularly hanging sides, forbid all approach by land. The lake is thus the only and the common communication between those who live above it and the other parts of the district of Aardal. There were many boats of us in company, the most of which strove with great exertion to row past one another. They are excellent rowers; and this passage to and from church never takes place without this sort of contest, the only object of which is the honour of winning. It is pleasant to witness this contest. Six men, commonly stout young fellows, sit at the oars; the boat darts forward like an arrow; and you may imagine the vigour which is exerted, when the blade of the oar sometimes snaps in the water,—a circumstance which happened to the boat that was striving with ours, and which, in consequence, fell a considerable way behind. But as they had got a reserve oar, which was put out in haste, our boat, which was deeply laden, having about twenty people in her, was quickly overtaken and passed. So soon as the boat you contend with falls a good way behind, or it is perceived that in spite of all exertion you are not able to keep up, the strife is over, though it ceases not without some sarcastic jokes on the part of the conquerors. After this, though they still push briskly forward, they go on more equally

in company. We pushed on, and were immediately run on the beautiful Farnæs, where the river Utledal, which, by a course of six miles from where it rises in the mountains of Guldbrands-dal, runs through Utledal, Vettie's Giel, Svalemsdal, and Farnæs, empties itself by seven mouths. It was already evening, and pretty dark; I therefore took up my night's quarters at the farm-house of Vee, a pretty large farm, which has an interesting situation on the south side of the river Utledal, not far from Farnæs. There my appointed guide was already waiting for me, a houseman (a sort of subtenant in Norway), who was well acquainted with the family at Vettie. We set out on our road early in the morning, and as this was at first over fine even plains, we mounted on horseback. In the neighbourhood of Vee we passed a mighty water-fall, which, from a side dale called Rösdale, rushes down in one fall of 150 fathoms. Farther east is Valdersdal, so called, because in a stretch of 4 miles, (about 27 English,) it goes up to the mountains of Valders. Through this dale runs the river Thya, coming from the lake Thya, which here descends in a large fall, forming three cascades. Over its mouth is carried a bridge. A little farther on in the vale, on the other side of Utledal River, the course of which we follow the whole way, you see a rocky mountain called Möekamp, lying east and west, as if it were sunk between the far higher mountains on each side. Round the foot of this lie a couple of farm-houses, and several housemen's places. From the River Thya you come on a very high sand-hill, under which lies the farm of Möe. When you have toiled up this difficult, and very steep hill, you come to Sualem-hill, a little mountain ridge lying east and west, and consisting of entirely naked, slippery rocks, on which it is both difficult and dangerous to ride. You now come to the fine plain land of Sualem, which, of considerable extent, stretches on to the farm of Jelde. You have here got about half a mile from Farnæs, and you begin to perceive that the Giel is near.

Nature now assumes a severe character; her smile totally vanishes; the dale contracts itself closer together; the black mountain masses tower higher up on both sides, casting abroad their melancholy shadows. Before you come to the farm-house of Jelde, you pass a bridge over the River Jelde, which, coming

from a very high pasture-glen belonging to the farm, gushes down in a fall of about 200 fathoms. Every thing is gigantic and threatening. It is Nature's grand style. Small objects disappear, and the heart beats with the anticipation of approaching danger. At Jelde, you do well to dismiss your horse, and trust to your own legs. It will now, too, be of importance to provide yourself with an additional guide. Farmer Civind offered to accompany me; but, as he could not himself go with me the whole way, he made his servant likewise be of the party. I had thus three companions well accustomed to this road, and, therefore, on their own part, altogether unconcerned about dangers which were familiar to them, but who could very well enter into the feelings of a person in a different mode of life, who, for the first time, trod a path the like to which he had never seen, nor could conceive. When Civind had found his axe, which he had long to look about for, and the use and necessity of which I had afterwards to learn, to my terror, we all set out.

At a short distance from the dwelling-house of Jelde farm this frightful way begins. The entrance to the Giel is altogether worthy of it. You climb up over the hill of Jelde. This is a projecting out-corner of the mountain, consisting of granite, which, with an inward bend, hangs over the river which washes its foot. It is thus impossible to find a lower road, as this precipice forms the bank of the river. It is a severe exertion to climb this steep and difficult path at such a height, and constantly on the brink of precipices.

It is probably this hill which has fixed the height of the path in the Giel itself; for otherwise, you see no reason why it should have been cut out, at such a height, on the side of this frightful wall of rock, that the person who falls over it, must be dashed to pieces, before he reaches the surface of the water. When you have reached the top of this hill, you turn round to the right hand, and enter into the Giel itself, by a bridge of pliant trunks of trees, laid over with birch-bark, and turf and gravel, that all swing under your feet. The mountain here hangs a little over the passenger's head, and you willingly incline to it as to a friendly support, to avoid seeing, and, if possible, to avoid thinking of the abyss you are swinging over, but of which, the gravel thrown

down by the motion of the bridge, is all the way putting you in mind. You are now in the Giel. Traveller, God be with you! —The path here is not broader than that a person can just stand on it with both feet beside each other. Sometimes you have only room for one foot; nay, at times, from the quantity of loose earth and small stones which you may well suppose are frequently tumbling down here, and covering the whole path, you find no place at all to stand on, but must, with your foot, in a manner scrape out such a place in these loose materials, which here lie over the surface of the whole precipice, the upper part of which forms a very sharp angle with your body, while the part below approaches frightfully near to a perpendicular line.

About half a quarter of a mile on in the Giel, on the north side of the river, high up towards the summit of the mountain, there opens on you, a cross valley, the remarkable Afdal. The houses on a farm which is here, stand on so steep a slope, that, while the under-beams rest with one end on the ground, to have a horizontal position, they must be supported on the opposite side, by a wall of 4 ells in height (8 feet English.) The fields, too, lie so steep, and so near the fearful precipice, that no person unaccustomed to it, would venture to set a foot on them. And when, from the Giel, you see their grass fields, which hang rather than lie over the deep below, and which are every year mowed with a kind of scythe, wrought by one hand, you can scarcely conceive the desperate courage which coolly plies its task where an abyss seems open to swallow the fool-hardy man.

A little above the dwelling-house, is a piece of ground, tolerably flat; and, when you inquire why they did not rather build there, you are told that it is impossible to build there, from the quantity of snow that tumbles down on it. Through this dale, runs the river Afdal, which rises from the summits of the mountains called the Young Harlots *. It runs past the house, at a distance of about 30 ells; and, at about 150 ells from it, with a

---

* These are reckoned among the highest mountains in Bergen Stift, higher than Galetind, the height of which is given at 5514 feet above the sea. They take their name from a singular tradition in the country. A marriage party, who were all very wicked persons, on their way to church, were changed, by the wrath of Heaven, into these rocky summits. There are seven of them, of which the bride and bridegroom are the highest.

noise like thunder, tumbles over the precipice in a tremendous fall. The violence of this, and the agitation produced by its rushing over, is such, especially in summer, that the house continually shakes; and every fluid which stands in an open vessel, exhibits a constant tremulous motion. The walls and the windows which are next the river, are always wet, from the vapour ascending from the fall. They told me, that this fall was 200 fathoms high; and, when you look down to the abyss below, and then raise your eye to where the river issues from this lofty vale, you can scarcely call it in question. Beside the fall in the hard granite precipice which it washes, they have mined a rut,—I cannot call it a way, though it serves for one, broad enough for one man; or, at most, a little well-trained horse. but not beside one another, to go upon it.

This rut, the roof of which is just so high, that a grown up person can stand upright in it, is the only way to the farmhouse till you get up to a considerable height. It reaches not, however, the whole way. There is a gap, which is filled up by pieces of timber, joined together, of 6 or 7 ells in length, one end of which rests on this rut, the other on a projection of the mountain, which likewise serves as a support to a bridge which goes over the fall. In these pieces of timber are cut notches, which serve for steps; and in going up these notches, while you see through the timbers the foaming cataract under you, and are involved in its mists, he must be a native of Leirdal who does not then feel that his life hangs on a few inches of slender tree. It is a matter of course, that neither this wooden path, nor the bridge itself, nor the rut in the side of the rock, are provided with any kind of rail or defence. A Leirdaller knows not the name, has not the conception of giddiness. He falls as other people do, although he stands where they would fall: he is dashed to pieces like them, but this comes from his inconceivable rashness, and from his not having wings. Of the ten years I have now been here, not one has passed without instances of persons being killed by falling over precipices. This is one of the common modes in which people die, and it awakens no particular sensation. They believe, however, that the spirits of these persons go about after death, and they have a particular name by which they distinguish them from other ghosts. When the farmer in Afdal brings any

thing to his house, when he comes to the river he must take it off the horse, and letting him go loose before, he and his servants must carry every thing upon their backs.

The farther we advanced in Vettie's Giel, our road became the more difficult and the more frightful. At one time you were stopped by snow that had tumbled down, and where it was only by passing quickly over the loose heaps you could avoid sliding down the steep, at once to be dashed against the rocks and to be drowned :—next you stood horrified at the sight of a wall of ice, the remainder of a frozen current, by which all farther advance seemed to be rendered impossible. But for this Civind had prepared himself. With his axe he cut in the clear solid ice a notch, in which he set one foot, then another in which he set his other foot, and in this manner continued to cut and go forward till he had reached the other side. The rest of us followed in the steps which he had thus cut. You must put on resolution; there is nothing else for it. With the utmost caution, your eye fixed steadily on the point where you are to tread, you set forward foot by foot, without stopping to draw your suppressed breath. For more than half a mile (more than three English miles), we went forward on the brink of a perfect abyss, in this manner, sometimes passing masses of snow not yet melted, sometimes those huge frozen mirrors which hung almost perpendicularly from the summit of the mountain to the gulph below, and over which the axe only, by steps scarcely a handbreadth, could form for us a dangerous path. A slip, an unsteady step, or giddiness itself, which always threatens to overwhelm the unaccustomed traveller, and in a moment the torrent becomes the grave of your mangled carcase. But such is your whole course through Vettie's Giel, on a path where it is not often you can set down both feet beside each other.

When overcome by the violence of the exertions I had to make, I stopped a moment. This rest, so far from being refreshing to me, was full of horror. It was better to go on, however exhausted. In doing so, your thoughts were so occupied with the place where you might find some footing, that you had but little time to observe the grimaces with which death seemed every where to gape around you. But set yourself down, you cannot avoid seeing yourself sitting on the brink of an

abyss; above you the high mountain ridge hanging over your head, below the more frightful steep sinking perpendicularly from your feet: on the opposite side of the Giel, the wildest torrents tumbling down hundreds of fathoms; whilst at the bottom, the river foaming and roaring, with a deafening sound, rushed on with the rapidity of an arrow, and the road you had to go, bent still far upon the sides of the precipice which hung over it: in short, you saw nothing but Nature in her terrors: I involuntarily shut my eyes; my heart beat, and, that I might not be overpowered by these sensations, I stood up, to expose myself to new dangers. I asked my guides if any body had ever come to mischief on this way. They recollected only one person, who, with a knapsack of birch-bark on his back, by a false step, had tumbled over from about the very spot where we were standing. From an irresistible apprehension that I might be the second, I pushed forward immediately from such a place, but yet I found no safer way.

It began now to rain, and as the part of the path on which we were was considered as dangerous, from stones that tumble down, we made all the speed we could. The bottom of the Giel began at last to widen a little; and at Hölifoss, about half a quarter of a mile from Vettie, (three quarters English), it becomes about 150 paces broad. In other places it is never above 30 ells broad, and in some places not more than 6 or 7. Here my guide Civind left me, and went back alone with his axe, of which he had made such good use, telling me, that now all the difficulties of the way were past; and they were so in comparison of those we had come through.

Höliefoss is a fall in Utledal River itself, of no great height, but of a force which you scarcely find in any other fall. and accompanied with a noise which deafens the ear. A mountain rock has here set itself fast in the bottom of the Giel: the river has been forced to dig itself a narrow passage between this rock and the high mountain precipice, between which it rushes forward with such irresistible violence, that stones thrown into it, or tumbling from the side of the mountain, are carried down on its surface.

It rained now so hard, that the water ran across our path: I quickened my pace, to reach the end of this fatiguing and

dangerous excursion. With all my haste, however, I could not escape being thoroughly wet. The path now descended gradually towards the river. The mountain, to the side of which, as to a wall, we had been, as it were, fastened the whole way, now turned a little off from us, leaving a broader, though an irregular way. On a sudden it goes off entirely to the right, opening a new side-valley, and, before I knew where I was, I stood on the fields of Vettie, only a little above the surface of the river. Heavy with my wet clothes, dropping with sweat, and exhausted by violent exertions, I was glad to reach the houseman's dwelling, which lay nearest us, there to repose a little, under cover, before I should attempt to mount the long and high hill on which stood the farm-house of Vettie.

On the road to it I was met by Olé, the goodman, who conducted me up. The family had just risen from dinner. Every thing was instantly carried off, as they did not think it good enough for me. On the table was immediately set their best butter and cheese, and smoked flesh, and flour-bread; and, in short, every thing they had to please the appetite of the weary traveller. But as there was not a dry thread on me, I felt very uncomfortable in my wet clothes. The goodman found a remedy for that; and from his chest I was provided with every thing I required. Clad from top to toe in his Sunday's clothes, I sat down, metamorphosed into a Leirdaller, amidst this friendly family, who could not cease from expressing their wonder at a visit as unexpected as unheard of before, and who did not know what kindness to shew me; complaining from their hearts, that I had not given them notice, that they might have been better prepared to receive me. His wife was in an advanced stage of pregnancy. I expressed my wishes for her safety on her approaching confinement; and asked her, How she would get the child taken to church.—O, answered she, smiling, when matters come that length, there will be no difficulty: the child is well wrapped up, and is carried to church, properly girt on the shoulders of the servant-man.—By the same way I have come?—Yes; we have no other.—Now, then, God be with both him and the child.—O, we are not afraid of the way, we are so accustomed to it; and after a few weeks it will be better, when all the ice will be away. By God's help I shall soon come to

church myself, when Father * shall lead me in.—I could not but think highly of her courage, her cheerfulness and composure. The goodman told me, that at the best season in summer the Giel can be traversed by a horse; and that then every thing is thus brought to the house, on the back of his own horse, who is accustomed to this road. One is less surprised at this, when he sees the lightness of the small Leirdal horses, and their most uncommon sure-footedness, by which they can go on the smallest paths, on the side of the most fearful precipices, setting one foot before another, in such a manner that no path can be too small for them. From the farm of Vettie, the Giel is continued upward, in a stretch of three miles, so that the whole length of it is more than four miles and a half (more than thirty English miles). Above Vettie farm, the goodman told me, it was more narrow, more difficult, and more frightful, than the part of it which I had seen. He and his people had often to go up that way for small timber, and other things necessary on the farm. On the sides of it, too, were the finest valley and mountain pastures, of the greatest value to their rearing of cattle. Their corn was sometimes destroyed in harvest by frost. For more than half the year, the two families living on this farm, the farmer himself, and his houseman, are cut off from all other human intercourse. In winter, the ordinary path is impassable from snow and ice, and especially from those frequent columns which leave traces of themselves a long way on in the summer, because the sun's rays, resting but a short time over this long, monstrous gulf, it is seldom before the month of July that this ice is all away. For a short time in winter, when the river Utledal is frozen, there may be a passage along the bottom of the Giel, but not without danger from the avalanches, which, with tremendous violence, tumble down into the deep; the very air of which overthrows every thing. In the end of harvest and the spring, all approach to and from Vettie is barred; in the end of harvest particularly, from the falling of earth and stones, which are then loosened by the frequent rains.

* Meaning the clergyman to whom she was speaking. It is still the custom, in the remote and simple districts of Norway, that when a woman goes first to church after her confinement, the parish clergyman meets her at the door, and leads her into church.

At a little distance behind the dwelling-house of Vettie, in the back ground of the dale, there rises up a large mountain precipice, over which, where a new Giel begins, there rushes the highest waterfall I had yet seen, called Markéfoss. High falls indeed are here so common, that they at least excite less attention, especially where the mass of water is not very considerable; but what seemed to me exceedingly singular in this one, was, that the fall is so perfectly perpendicular, that not one drop of its water touches the whole side of the mountain. From the gap through which it issues, the mountain bends inward like the side of an arch, in such a manner, that if the place were accessible, one might make a passage between the mountain and the fall. As the mass of water here meets with no resistance, it makes no alarming noise; I only heard its distant sound in the bottom of the Giel, which it was impossible for me to see, as all view and all approach is barred by high sharp-pointed rocks, and a chaotic assemblage of large blocks of granite. Over this precipice lie the pasture-grounds of Vettie, where are some of the finest sketches of wood to be found perhaps in the whole province. Here grow the finest trees for masts, of uncommon height and thickness, unused and incapable of being used, because they cannot be got down through the Foss, without being splintered into a thousand pieces. It is difficult to get even common house timber this way, for perhaps not one out of ten pieces remain of sufficient length. In former times, this wood was the property of the Copper-work Company of Aardal, which had its best supply of charcoal from it. It was the more valuable to them, that its situation excluded it from every other use. I saw a man going up the precipice which leads to this wood. At the distance at which I stood, he seemed like an insect creeping up a wall. By frequent turnings from one hand to another it is rendered possible to go up a path, from which, however, nothing is more easy than to break a neck. But born and brought up as the people are here amidst such dangers, they disregard or are not sensible of them. The boy, the youth, grows up amidst venturous feats, and courage is his life's constant guide. Of the mountain-summits here, I mention only Fleskeuaastiud, because it is considered as the highest next to the summits of the Young Harlots.

I spent the night at Vettie, and was next morning out with the goodman to have a full view of his little romantic dale, where hill and valley, wood and water, the lofty black mountain-masses, over which the majestic fall poured its foaming silver, were all grouped in the most picturesque manner, in a landscape in which the strongest features of Nature were wonderfully blended with her sweetest smiles. The severe and the gay moderated one another by being mingled in one look. The chorus of the feathered tribe only was wanting in wood and forest. The temperature here is too severe for the delicate songsters of the sky; nowhere does the lark mount in his airy flight; even the thrush flies to milder regions. The cuckoo only, with his monotonous song, for a short time enlivens the silence of the wood.

I had learned from the goodwife how they carry their children from this place to church. I was curious to learn of her husband, how they got the dead carried from it to the church-yard. It is impossible that two people could go beside one another in the Giel; and I could not conceive that a coffin could be placed on horse-back. He gave me the following account. The dead body, wrapped in linen, is laid on a plank, in which are bored holes at both ends, to which are fastened handles of cord. To this plank the body is lashed, and is thus carried by two men, one before and another behind, through the Giel, till they come to the farm-house of Selde, where it is laid in a coffin, and carried in the common way to the church-yard. If any one die in winter, at a time when the bottom of the Giel is not passable, or in the spring or harvest, they endeavour to preserve the body in a frozen state, which is seldom difficult, till it can be carried off in the manner I have just mentioned. Still more singular was the method which the goodman told me was employed several years ago, to convey a dead body to the grave, from a houseman's place in Vormelien. This place lies in Utledale, which borders with the fields of Vettie. It has a most frightful situation, deep in the Giel, by the side of the river; and like Vettie, has no other road but a small steep path, on the side of the most dreadful precipices. As the inhabitants of this place had been often changed, there had been no deaths here. It happened, at last, for the first time, that a young man of seventeen years of age died. It never occurred to them to

think how they should get him carried to the grave, and a coffin is prepared for him in the house. The body is laid in it and carried out; and now, for the first time, they perceive with amazement that it is impossible in this way to get on with it. What is to be done? Good counsel is here precious. They leave the coffin as a *memento mori* at home, and set the dead body astride on a horse; the legs are tied under the horse's belly, —a bag of hay is well fastened on the horse's shoulders, to which the body leans forward, and is made fast; and in this manner rode the dead man over the mountains to his resting place in Forthuus Church in Lyster,—a fearful horseman.

After a long and fatiguing weary walk, I returned with the goodman to his house. A rich soup, made from excellent wedder mutton, killed the night before, smoked from the white clad table. And what is not excellent when it is presented to you by hospitable hands! So long as nature and generous simplicity is preferred to art and ceremony, so long will such a patriarchal meal, to which you are invited with a welcome from the heart, and which is gratefully received, be preferred to ostentation and extravagance. They wished me much to remain another day at Vettie; but as I had fixed to go that day to Aftdal, and then over the mountains to some of the mines at Aardal Copperworks, I was obliged to bid farewell to the worthy people, whose extraordinary place of residence I had for the first, and I believe also for the last time, now seen.

With my former guides, and a man-servant from Vettie, I set out on this fearful way back. From the heavy rain, much of the ice had disappeared; and I had the dangerous pleasure of seeing one of these masses of ice tumbling down in a thousand pieces into the gulf: over two only of the most obstinate were we obliged to cut our road over the ice. In good time I reached Ielde; and here, where nobody dreamt of danger, my horse tumbled with me over the side of a little hill. Thus ended an excursion, the whole object, and the whole result, of which was the view of Vettie's Giel.

Art. XVIII.—*On the Heights of the principal Snowy Peaks of the Himálaya Mountains.* By Captain J. A. Hodgson and Lieutenant J. D. Herbert *.

On the successful termination of the first campaign against the armies of Nepal in 1815, in which they were expelled from their conquests in the mountains between the rivers Settlej and Kali (or Gogra), by the British forces under the respective commands of Major-Generals Ochterlony and Martindell, and Colonel Nicholls; and the provinces of Gerwhal, Sirmor, Hindur, Bisaher and Kamaon, with the exception of some small districts, being restored by the British government to the Hindú Rájás, their ancient possessors, the Most Noble the Governor-General in Council was pleased to direct, that surveys of the above countries should be executed by Captain Webb and myself. To Captain Webb, who was then in Kamaon, the survey of that province, and of the eastern parts of Gerhwal, was assigned; and to me that of the western part of Gerhwal, and of the mountains between the Ganges and Settlej rivers. My instructions were summarily, " to make a correct survey of the liberated provinces of Gerhwal, Sirmor and Hindur, as well as of the countries to the north of them reaching to the Himálaya, a tract which comprises the sources of the Ganges, Jumna, Tonse (hitherto unknown, though larger than the Jumna), and Settlej rivers; and which is bounded by some of the noblest mountains in the world." I was ordered to carry on my researches as far as rationally practicable, and Colonel Crawford, then Surveyor-General, was directed to prepare such instructions for me as he might deem necessary. That distinguished and scientific officer, alike versed in the theory and practice of great surveys of this nature, approved of the methods I had suggested for carrying on my operations, and generally directed me to be guided by such circumstances as might appear to me most conducive to the objects in contemplation.

* This paper is a brief extract from the long and interesting memoir of these able and active officers, as published in the *Asiatic Researches*, vol. xiv. p. 187.—373. Ed.

It will be acknowledged, that the extension of geographical knowledge is a desirable object, and it cannot be denied that, to ascertain the heights and positions of the snowy peaks of the Himálaya, is not only an interesting and curious but very useful inquiry; for when their latitudes and longitudes are known, the geographical position of any place, from whence one, or more of them, are *visible*, may be determined with ease and accuracy. We have every facility and opportunity of observing some of these resplendent and lofty guides, in the great extent of 15½ degrees of longitude, now either in our possession, or under our influence and controul, from the banks of the river Settlej at Ludiana, to beyond those of the Burampooter in Bengal.

In all this belt, the outline of some of the snowy peaks may frequently be observed, in clear weather, to the distance of 150 miles and upwards, with sufficient distinctness for an observer to fix his *own position*, by obvious methods, and thus to be enabled to correct the geography of the older maps. But as yet, we do not, by Captain Webb's survey, and that of Lieutenant Herbert and myself, know the precise latitudes and longitudes of any peaks further to the SE. than the latitude of 29° 49′ 43″, and longitude 81°.2 nearly. It would be very satisfactory to determine the positions of those more eastern peaks visible from Patna, Monghir, Bhagalpúr, and Rájmal, and this may be done with considerable precision, by their *azimuths*, taken at the above places, with their observed differences of latitude, and differences of longitude, taken with good chronometers, carried down the river in fast going light boats, when the stream is most rapid: the boats would reach Monghir from Patna in a day, and two good chronometers ought to give the difference of latitude within a quarter of a mile. The chronometrical measures may also be compared and corrected by differences of longitude taken by the firing of gunpowder: the flash of half a pound of gunpowder, fired at the hill-house at Pír Pahár near Monghir, would be seen at Janghíra rock, from which a flash would be seen at Patter Ghatta, below Bhagalpúr, and thence at Pír Pointí or Sicri Gallí, or probably Rajmal.

After giving an account of the instruments employed, and the method of observation, Captain Hodgson remarks:

"In settling, finally, which it is hoped the present operations (combined with Captain Webb's) will do, the heights of some of the principal Himálaya peaks, a point on which even so great an authority as De Humboldt has fallen into error, we have imagined that we could not be too explicit in describing the instruments, and in detailing, not only our original observations, and the methods of calculation, but even the several steps of the process itself, from which the results are deduced. We have been aware, that it is only this full and candid disclosure, in which many things are met with that might have been glossed over, that can give a conclusion of *so much interest* any weight; and while we deprecate the theorist's pronouncing too decidedly on the value of results, which may appear to him much too discordant, we feel confident, that, in the eyes of the practised observer, who will consider the nature of our instruments, and the difficulties with which we had to contend, these very discrepancies will prove our strongest claim to his confidence."

Lieutenant Herbert next gives a minute account of his method of measuring a base line of 21,754.8 feet, and then a detail of all the angles of the triangulation, founded on the measured base.

The following are the general results of the operations, in so far as concerns the Snowy Peaks. We have retained the letters and references in Captain Hodgson's Tables, as there is no other way of identifying the peaks.

TABLE of the Heights of the Snowy Peaks of the Himálaya Mountains.

	Height above the Sea, in English Feet.
Uchalarú, F.	21,884
Ditto,	20,129
Ditto, C.	21,773
Ditto, Q.	19,732
Ditto, J.	16,857
Ditto, great E.	20,765
Kedar Kanta, L.	19,352
Ditto, No. 39.	19,321
Ditto, great E.	20,747

TABLE of Heights,—continued.

	Height above the Sea, in English Feet.
Kedar Kanta, H. left peak,	20,356
Ditto, H. middle peak, -	20,508
Kedar Kanta, C. - -	21,787
Ditto, the Cone, - -	21,018
Surkanda, G. - - -	20,144
Ditto, F. - - -	21,925
Ditto, Q. - - -	19,804
Ditto, A. No. 1. - -	23,371
Ditto, A. No. 2. - -	25,589
Ditto, Moira, - - -	22,632
Surkanda, B. middle peak,	23,281
Ditto, P. - - -	23,157
Kedar Kanta, No. 46. -	18,884
Kedar Kanta, Kot Gerh peak,	17,186
Chúr Raldeng, - -	21,251
Whartú, pyramidal peak, -	17,214
Surkandu, D. - - -	22,894
Chandra Badaní, D. -	22,912
Surkanda, U. - - -	21,452
Whartú, western F. -	18,646
Ditto, black peak, - -	16,043
Ditto, Kot Gerh peak, -	17,200
Túngrú, western F. -	18,632
Kedar Kanta, black E. -	20,995
Kedar Kanta, low E. -	19,962
Surkanda, H. right peak, -	20,508
Ditto, H. middle peak, -	20,341
Uchalárú, Q.—C. - -	19,370
Ditto, F.—C. - - -	21,612

Art. XIX.—*Sketch of the Geognosy of Madeira and Porto Santo.* By T. Edward Bowdich, Esq. Conductor of the Mission to Ashantee, Member of the Wernerian Natural History Society, Natural History Society of Wetteravia, &c.

I SUBMIT two or three of the leading geological facts, without intruding those conclusions which my excursions in Madeira

and Porto Santo have yielded, lest there should be more delay than I anticipate in the publication of my detailed description of these islands. The sketch of a Flora, and the fuller report on the geographical distribution of plants in Madeira, which I have already forwarded to Sir Humphry Davy and the Cambridge Philosophical Society, make it unnecessary to say any thing more just now on either head, unless it be to remark that I have since found the Isatis tinctoria, and a male Date-tree, neither of which I had then met with.

I must premise that it is my present intention, and I hope to persevere throughout my journey, (even should it be extended some years by the support of the Government), to accompany the MSS. I may send home from time to time, by accurate drawings of the most interesting of those new objects of Natural History I may meet with in the different parts of Africa I hope to be permitted and enabled to visit. It takes away very much from the usefulness of a journey, when it is attempted to save the trouble of making drawings, by substituting for that concise description of the object which will suffice with a good figure, a tiresome verbal detail of minutiæ, wholly uninteresting, and frequently unintelligible without the aid of the pencil. The only probable difficulty is, that no publisher will undertake to go to the expence of having these figures engraved; and that they may thus be lost to the naturalist and others, who would feel an interest in referring to them, as illustrations of the text. Contemplating this probability, I have determined to obviate it in some degree, by regularly transmitting one set of these drawings to Sir Humphry Davy, to deposit wherever he thinks they may be most readily and conveniently consulted by the naturalists of my own country, who will always find them numbered, so as to correspond with the references in the text of my travels. I shall also transmit a duplicate set of these drawings, to be deposited for the same purpose in the library of the French Institute. The two sets of 107 figures, (several of which are coloured) referred to in this first part, have been forwarded with the manuscript.

Not daring to venture as far as the granite rocks of Cintra, (which are about 1600 feet above the level of the sea), from the hourly expectation of the departure of the vessel to Madeira, I contented myself with crossing the river to Almada. The form

tion was totally different from the three which were in view on the northern side of the river, viz. the granite at Cintra; the transition limestone above Guida; and the basalt capping the hill between the aqueduct and the city; the two latter of which are pretty fully described in my MS. work. It was a range of *Calcaire grossiere*, about 300 feet high, and extending some miles along the river. It was soft, but firm, frequently very sandy, sometimes of an orange-yellow, (especially within), but generally of a greenish and yellowish grey. Pebbles of silex were occasionally imbedded; and, more frequently, masses resembling clay; it soiled the fingers,—effervesced moderately,—and seemed deposited in deep horizontal beds, more compact upwards. The shells were so thickly imbedded, that whole masses appeared to be exclusively composed of them. They were all marine, with the exception of the Balenius montanus, and comprehended three species of Ostrea, (O. plicatula, O. edulis and O. canalis); the Panopæa Faujasii, the Cyprina islandica, the Pecten vulgaris, and P. saxatilis, with three species of Venus, Fig. 30, 31, 32; three of Turritelle, Fig. 23, 24, 25; a Cardium, Fig. 33; a Balanus, Fig. 34; a Nassa, Fig. 28, and a Murex, Fig. 26, which, possessing no specific descriptions, I could not determine, and have, therefore, drawn, with one valve of a shell of considerable size, and of an orange colour; Fig 19, which I do not recognise, and a smaller one, Fig. 20, which cannot be referred either to Tellina, Venus, or Cytherea, but which resembles all of them.

At St Vicente, on the north side of Madeira, I found a similar limestone to that which I have before described beneath the basalt at Lisbon. Generally speaking, however, it is of a whiter colour, more crystalline in its texture, contains very little imbedded siliceous matter, and scarcely any compact masses; yet from analogy, and from the great depth of the bed, (being nearly 700 feet from its junction with the superincumbent basalt, to my last glimpse of it in the bed of the torrent, nearly level with the sea), without a single alternation, I have no doubt of its being transition rather than primitive limestone. Its more crystalline texture is probably owing to its vicinity to the basalt. The drift line of the junction is horizontal; and the limestone has evidently been deposited regularly and frequently, without the

smallest trace of disturbance or confusion. Continuing about a furlong to the northward, and descending a water-course, (about a mile in a direct line from the beach,) I found dikes of decomposing basalt intersecting the limestone, which, from their form and direction, I should say had evidently descended from above; and, instead of filling up from below, had flowed into the gaps created in the limestone, by the convulsions which rent the original structure of Madeira, and preceded its new form.

The lowest bed of the sandstone above the calcareous tufa, (which is the lowest visible deposit at Porto Santo, and is intersected by basaltic dikes), is hard and solid, and is used as a building stone. I have given a particular description, which I need not introduce here, of its characters and gradations. The upper or looser sandstone, which yielded to the fingers, contained in its upper and outer surface, an Ampullina (or marine Ampullaria), Fig. 58; a large Helix, resembling the H. plicata, Fig. 57, but differing from the plate being on the last whorl, which does not advance as far into the mouth; a still larger, wholly unknown to me, Fig. 56; and two others, the one, Fig. 50, a Helicella of Ferussac's groupe Marginatæ; the other, a Helicigona, of the groupe Vortices. I found no Ampullinæ amongst the shells of the beach, (seventeen of which being new species, or at least not noticed by Lamarck, and unknown to me, are drawn and described); no Bulimi any where; and the existing Helices (thickly strewed over the soil formed by the calcareous tufa, and found very sparingly on the fig-trees in the sandy plain,) were specifically distinct from the considerably smaller ones, forming entire masses of the loose sandstone, and generically distinct from the very large species imbedded in its surface.

The flaky sandstone frequently formed isolated ledges or hillocks of a most picturesque appearance, on the southern part of the plain; numerous flakes being regularly piled on each other, shooting upwards from the soil in angles of 45°, and seeming to emulate the lofty peaks of tufa behind them; Plate VI. B. Embedded on these hillocks, are numerous close-grained, indurated, cuneiform, hollow masses, with smaller lateral branches, which I conceive to have been formed by the sand having enveloped plants or fragments of wood, subsequently and entirely decomposed.

I took a boat and went to the small island of Baxo: it is only half a mile distant from the south-west end of Porto Santo, (entirely composed of cliffs of tufa with dikes), from which it has been evidently separated. To get at all the strata in succession, I was obliged to climb up an almost perpendicular height of about 220 feet on my hands and knees. I first ascended about 100 feet of the same tufa, which I have described at Porto Santo; then twelve feet of limestone, of a granular sandy structure, glimmering lustre, and emitting an alliaceous odour when struck; it contained no fossils, or at least none that I could discover, after examining and breaking away its surface in various directions, and after splitting numerous large fragments; it is of a buff-ground, sprinkled with grey and red spots or grains. Above this I found about fifty feet of a conglomerate of nodules of basalt, or rather of wacke, (from its colour, fracture, and specific gravity), which I need not describe particularly here. I then climbed over from eight to ten feet of a conglomerate limestone, generally of a chalky white, soiling the fingers, sometimes of a whitish blue, and containing large nodules of wacke and imbedded masses of a granular, sandy limestone, resembling that before described. The white part of this limestone presented great masses of Lamarck's Catenipora, (Tubipora catenulata, *Lin. Gm.*); and with much difficulty I chiselled out some perfect moulds of a large Cardium, Fig. 88, of the Cardium edule; one end of a Solen; of a Solenemya, Fig. 55; moulds of various sized Venuses; a Voluta, Fig. 54; a Turritella; a Conus, like that at Lisbon, Fig. 27; the Pecten multiradiatus, and the Pecten glaber, (neither of which species I believe have before been found in a fossil state), and the fragment of a large white Pecten, Fig. 59. Above this shelly limestone was about six feet of a fine-grained, indurated sandstone, deposited in layers, with projecting ledges, and acquiring a scoriaceous appearance, and dark grey colour, on the outer surface, from exposure to the atmosphere, but presenting an orange-brown within, and effervescing. On this rested a conglomerate, about fifty feet deep, of nodules of wacke, of a lesser portion of the orange-coloured ferruginous sand, and of small fragments of wacke, emerging like nail-heads, and coated (with the exception of the upper surface) with an indurated grey clay, which also lines small cavities in a mamillated

form. No part of this conglomerate effervesced; but it was covered by a shallow horizontal bed of sandstone, of the same nature as that above the fetid limestone.

Through all these different horizontal masses, that is, from the summit of the table-land, of which this island is principally formed, to the sea, a depth of about 240 feet, descend, more or less perpendicularly, numerous basaltic dikes; sometimes jutting out like walls, and serving as rude stairs in the ascent; at others, nearly even with the surface of the various rocks they intersect; and frequently running parallel with the beach for some distance at the water's edge, and forming into piers. In some parts, their surface was covered with considerable patches of a dull coralloidal carbonate of lime, and in the basalt of the dikes on the north side, (for it was the eastward face which afforded me the section I have described), I found beautiful crystals of nepheline. In the dikes immediately north of Pas Juliana, I found a deposit of native alum.

The limestone beneath the basalt of Madeira, is evidently of the same nature and formation as that beneath the basalt at Lisbon. The shelly limestone of Baxo is distinct from that at Almada on the Tagus; but it is probably of the same formation as the shelly limestone mentioned by Baron de Humboldt as covered by basalt, on the coast of Portugal. Of what formation is the limestone found on the coast of Africa, opposite to Teneriffe? And does that, subordinate to the tufa at Lancersta and Forteventuria, resemble either of those at Baxo *?

I made the height of the Peak 6164 feet †; and I think it was impossible for the day to be more favourable. I had taken the angle of elevation of the Peak of Ruivo with a reflecting circle, from the point generally visited by strangers for the best view of the Coural, and adjoining the Pico des Bordes, know-

---

* Humboldt's *Rel. Hist.*, l. 1. c. 2., and *Supplement*, p. 641. 4to.

† Fortin's Barom. 619.65, T. 9. 45, T. d. 9.45. C., 49. F., in the turret of Mr Veitch's house in Funchal, 154 feet above the level of the sea, (allowing 7 feet for the rise of the tide at the syzygies, when the height of the turret was determined) 770.70. T. 20.5, F. d. 20.5. C, 69. F. $T-T'=16^m, 2$; $\frac{1720}{1000}\times 2\,(t+t')=103^m 2$, correction for latitude 8^m.

ing that I could get its horizontal distance from Ruivo very accurately from Lieut.-Col. Paulo Dias de Almeida's *Survey*, just completed, after six years' labour, drawn originally on a scale of 28 inches to a Portuguese league, and containing even every quinta on the island. My own attempts to get a sufficient base by angles from a smaller one, measured with the aid of an artificial horizon of crystal and a proof telescope, (*lunette d'epreuve*,) failed from unfavourable weather.

6° 6′ 20″ apparent angle of Ruivo.	
26 refraction.	
6 5′54 which, with 24805 feet for the horizontal distance, gives	2578 feet.
Height of apparent above true level for 24805 feet, -	15
Height of point of view above the level of the sea, -	3710
Height of Ruivo,	6303

being 139 feet more than that given by the barometer, which was Fortius, and had been compared with that of the Observatory for several weeks.

M. Von Buch, and Professor Smith, found the Torrinhas (notoriously lower than the Pico Ruivo), 5857 feet above the sea. All these circumstances considered, I cannot help feeling some confidence in the result of my own observations, although I observed by Captain Sabine's recent article in the Journal of Sciences, that he made it only 5438 feet above the level of the sea. Baron de Humboldt found the decrease of caloric at Teneriffe, to be 94 toises for every degree of the centrigrade thermometer * ; De Saussure at Etna, 91 toises; my observation gives 89 toises, or 5 less than De Humboldt's. This would seem to be a further evidence in favour of the greater height of Ruivo. I have measured several other peaks.

I have not room for any zoological extracts ; and will merely ~~observe, that~~ I have had the good fortune to meet with a Chiroptera, two birds, five fishes, and one mollusca, generically new ; eight new species of fishes are drawn in addition.

I have submitted my authorities and evidence for concluding, that Kirwan's informants led him to rate the mean temperature of Funchal nearly 3° too high, (*i. e.* 68.9 instead of 66°), as he did that of the Havannah.

* Humboldt, *Mem. d'Arcueil*, p. 602.

"A Funchal la temperature des caves paraite être, de 16° 2′ C. (61° F.), par consequens de 4° 6′ (71° 9′ F.) au dessous de la temperature de l'air. Nous reviendrons dans la suite sur cette difference remarquable entre les souterrains à l'isle de Madère et l'atmosphére circonvoisine *." I think I may venture to contradict this anomalous difference. There is not a subterraneous cellar or crypt in the island: the deepest caverns are the "Furnaces of St John," (close to Funchal on the NW., and about 240 feet above the sea), formed out of a deep bed of scoriæ. In the largest (128 feet to the innermost part, which is wide, spacious, and lofty, and about 15 feet below the level of the mouth), I made the following observations. Nov. 4., 1 P. M., Temp. of air 71° 5, Hyg. 51°, Temp. of the inmost part of the cavern 67°, Hyg. 78¼°. Jan. 4., 2 P. M., Temp. of air 66°, just within the mouth 64°, inmost part 63½°. Again, in the cavern at Phaye Formosa, close to the sea, about three miles west of Funchal, and upwards of 39 feet deep, I found a difference of only 3° F.; and in that of St Roque, about 1000 feet above the sea, north of Funchal, and nearly 60 feet deep, a difference of only 4° F. There is an extraordinary difference, however, between the temperature of the wells and that of the air of Funchal, the former (Mr Lundie's, Mr Young's, and Mr Sortie's, all upwards of 20 feet deep, and in the open air,) being 58°, when the latter was 69°; but this is explained by recollecting, that these wells are supplied by streams which descend from heights of 3800 feet behind the town, where there would be a corresponding difference in the mean temperature; for that of the spring near the Mount Church, (inclosed at the expence of Consul Murray), and about 1900 feet above the wells in question, was 58°, the air within being 62°, by an observation which I made in October.

Art. XX.—*Account of Mr Ronalds' Pendulum Doubler of Electricity.*

In a work just published by Mr Ronalds, entitled, "Description of an Electrical Telegraph, and of some other Electrical

---

* Humboldt. *Annales de Chimie*, p. 602. *Rel. Hist.*, p. 424. 4to. I quote my MS. extracts from these expensive works, and have omitted to note the volume.

Apparatus," we find, among many other ingenious contrivances, one of a Pendulum Doubler, which we consider highly worthy of notice.

"In order to shew that he could keep his telegraphic wire constantly electrified from a very small source of electricity, Mr Ronalds made the bob of a pendulum perform the part of the centre plate of a doubler on Bennet's or Nicholson's construction.* The instrument thus modified, he found convenient, not only for its usual purpose, but for all those experiments where a constant flow of small quantities of electricity is required to supply what is dissipated along imperfect insulation.

"The instrument is represented in Fig. 4. of Plate IX., where A and B are the two stationary plates, fixed upon glass supports; C is the bob, attached to the pendulum rod D by the glass insulator *e*; its form is a plano-convex lens, and the interior is filled with lead; *f* is a small cylinder, through which screws pass to connect it with C, and to adjust the plane of C exactly parallel to the plane of vibration; *g* is another insulator, carrying at its lower end the bow of wire *h*, the left side extremity of which, is situated nearly in the same perpendicular plane as the end of the wire *m*, and the right side is nearly in the same perpendicular plane as the end of *n*; *i* is a wire fixed perpendicularly into C; and *k* another, fixed (perpendicularly to the plane of vibration) into the brass cap at the end of the pendulum-rod; *l* is a wire, screwed into the upper edge of the plate B; *m* is a long wire, fixed into the lower edge of B, and approaching to within a small distance of A, where it is bent at a right angle, and then projects in a line perpendicular to the plane of vibration; *n* is another wire, fixed into the edge of A, and projecting in a similar direction (after it has also been bent); but the length of the *projecting part* of *m* is considerably less than that of *n*, in order that the *right side* of the bow *h*, may pass the end of *m*, without touching it; lastly, *o* is a wire, fixed perpendicularly into the base of the instrument.

"Since every body may not happen to have seen the *revolving* doubler of Nicholson or Bennet described, I shall shortly state the mode of action by which this pendulum doubler produces, by the motion of a common clock, a constant flow of electricity. It is seen, that when the centre of the bob C arrives opposite to

the centre of the plate A, the *insulated* bent wire *h*, will touch, at the same moment, the ends of the wires *m* and *n*, and establish thereby, a metallic communication between A and B; and that the wire *i*, by touching the wire *o* at the same moment also, will establish a communication between C and the earth. Now, by one of the laws of induction or compensation,—*i. e.* that property which any *insulated* conducting surface, possesses, when placed opposite to an *uninsulated* conducting surface, with a plate of air (or other semi-conducting or insulating body) interposed, of condensing on, or attracting to itself (within certain limits) the electricity which has been given to insulated conductors in communication with it, *and, being thus charged, of inducing a contrary state of electricity on the uninsulated opposed surface*,—by this law of induction, I say, if a quantity of *positive* electricity, producing a tension = 1 degree in the electrometer, be given to either A or B, whilst the centres of A and C are opposite to each other, that quantity will be nearly all condensed on A, and C will have a tension = nearly 1 of *negative* electricity.

"If C be now allowed to begin its vibration, the connection of A and B with each other will be instantly broken, as also that of C with the earth, and they will be all insulated, and all retaining the electric states which they possessed before the connections were broken (*i. e.* A will be positive nearly = 1; B negative nearly = 1; and C positive almost 0.)

"When C has arrived opposite to B, the *uninsulated* wire *k* will touch the wire *l*, and thus place B in connection with the earth; therefore C, by virtue of its negative charge, will induce a positive charge in it nearly = 1.

"When C arrives a second time opposite to A, all the former connections will be re-established, and the charge of B will (by means of the wire *m*) be nearly all condensed on, and added to the original charge of A, making a tension nearly = 2 of positive electricity, which tension will induce a tension nearly = 2 of negative electricity on C.

"When C arrives again opposite to A, the same process recurs as before; and, when it returns a third time to A, the charge of B, being added to A, will produce a tension nearly = 4.

"And so the charges in A and C would go on, nearly *doubling*

at each vibration of the pendulum, until their tensions would arrive at such a point as to cause a spark to pass between them.

"But P is a Leyden jar, furnished with a Lane's discharging electrometer *q*; a connection is established by means of a small chain between it and A, and the distance between the two balls, *r* and *s*, is considerably less than that between A and C; therefore the spark will be given to the jar: and a spark will be continued to be given at the completion of almost every second vibration, until it is charged almost as highly as A is capable of being charged, or the sparks will continually supply the loss of electricity by any defect of insulation, either of the jar, or of any conducting body, in connection with its interior coating within certain limits. My plates and bob are four inches in diameter *.

"It has been proposed to adopt large doublers instead of the common machines, for exciting electricity in large quantities, with a view to the saving of labour; and Mr Read has hinted at his knowledge of a method to cause the centre plates of revolving doublers to recede from the others, in proportion as the charges advance (a necessary condition, if large quantities of electricity are to be obtained); but he died without having made it public.

"Could not a *fine screw* be cut upon the axis which carries the centre plate, passing through the common support of the other two, which should *partially* produce the effect desired? Or, could not such a screw be made to act upon levers, &c. which should proportion its recession exactly to the advance of the charges? The affair would not be very difficult to a clever mechanist, perhaps."

Art. XXI.—*Biographical Notice of Baron Samuel Gustavus Hermelin.*

The memory of this philosopher should be equally dear to geographers and those who cultivate the mining art.

---

* The contacts of the wires do not impede the velocity of the vibrations, because they are made small enough to act as springs of a required force; but the electric attractions of the plates and bob *do* tend to do so. The pendulum is suspended by two springs, placed one at each extremity of a cross piece, to which the rod is attached, for the purpose of preventing the bob from being drawn, by these attractions, out of its assigned plane of vibration, as much as possible.

Born at Stockholm in 1744, of a noble family, his father having attained the eminent dignity of Senator of the kingdom, he was fortunately destined to undertake the administration of the mines, the most important source of wealth which Sweden possesses. He commenced by visiting the principal establishments of this kind in the kingdom, and paid particular attention to the celebrated copper-mine of *Fahlun*, where he contributed to establish a manufacture of vitriol, sulphur, and colcothar. He was also actively occupied with the gold-mine of Ædelfors.

After having acquired a profound knowledge of every thing remarkable in this department that Scandinavia presented, he obtained permission to visit foreign countries also. He travelled through Germany, the Low Countries, and France, and embarked for America; charged, at the same time, on the part of Sweden, with a political mission to the United States. He visited almost all parts of this country, and returned to Sweden, by England, towards the end of 1784.

He now became anxious to improve the knowledge of the geography, geology, and statistics of Sweden, which seemed to him to be as yet in a very imperfect condition. He therefore caused to be explored, at his own expence, the northern provinces of the kingdom, which were less known than the others. The result of these journeys, was a map of Westro-Bothnia and Lapland; and this was the commencement of the great geographical enterprise to which Baron Hermelin devoted, for a period of fifteen years, his most assiduous cares, and a great part of his fortune. Unfortunately, the publication of the twenty-six first maps having exhausted his pecuniary resources, he was obliged, in 1810, to give up the remaining part of the work to a company; but he acted a principal part in this association, and had the happiness, before his death, of seeing this grand atlas of Sweden entirely completed,—a monument raised to science, and his country, by a single individual, at the expence of the greatest sacrifices.

His patriotic efforts were not limited to this single enterprise, great as it was. Feeling for the extreme poverty to which the inhabitants of the most northern provinces of Sweden are reduced, and knowing the abundance and productiveness of the ores of iron which these provinces possess, he judged that the best means of being useful to them, would be to establish fur-

naces and forges. Three of these manufactories he established in Bothnia. He opened new roads, and perfected the means of conveyance by water; founded colonies, and introduced an agriculture unknown till then. But these interprises, which were not seconded, and which were crossed, in various ways, by accidental circumstances, exhausted, at length, M. Hermlin's resources. He was obliged to give up all his effects to his creditors; and he found, like many others, that, in the most useful and best calculated enterprises, the profits are reserved for others than those who have first tried them.

He had not, however, to complain of the ingratitude of all his fellow citizens. The College of Nobles, at the diet of 1800, caused a medal to be struck in his honour, with this inscription in Swedish:—"Presented to Hermelin, by his fellow citizens and friends, for having made his country better known, and for having enriched and peopled deserts."

The Stockholm Academy of Sciences admitted him as a member in 1771; and he often, by his liberality, seconded the scientific researches of this Society, and the journeys which it caused to be undertaken.

When he gave up, in 1815, the administration of the mines, after fifty-four years of service, not only were his appointments preserved to him, but the states of the kingdom added a pension of a thousand rix dollars,—a recompence well merited, adds the historian of the Academy, but moderate, if we consider the sacrifices of every kind which this excellent citizen had made for the common good.

Supporting his misfortune with a philosophic courage, he enjoyed, in retirement, the remembrance of all the good he had done, when death put an end to his useful and glorious career, on the 4th May 1820.

Baron Hermelin's eloge, of which the preceding is an abridgment, ends with an enumeration of the works which he composed, to the number of thirteen, including his academical memoirs, and works which would not have been published without his generous assistance.

We shall confine ourselves to the notice of the following works of Hermelin himself, which have been printed separately.

On the Smelting of Copper-ores. Stockholm, 1766.

On the Uses of the Stones which are furnished by the Quarries of Sweden. 1771.

On the Resources of different Provinces of Sweden. 1773.

Tables of the Population and Manufactures of Westro-Bothnia. Stockholm, 1801.

Essay of a Mineralogical Description of Lapland and Westro Bothnia. Stockholm, 1801.

Lastly, Mineralogical Maps of the principal Provinces of the South of Sweden.

ART. XXII.—*Account of* Mr Perkins' *method of applying his New Method of Generating Steam to the Boilers of ordinary Steam-Engines.*

HAVING in our last Number given a very full, and we trust perspicuous, account of Mr Perkins' new Steam-Engine, we shall now proceed to lay before the reader Mr Perkins' own account of his method of applying the new principle to steam-engines of the old construction. This account is taken from the specification of his patent, which is now open to the inspection of the public.

In order, however, that a correct idea may be formed of the original principle itself, we shall prefix Mr Perkins' own account of the generator, although we have already given a general description of it in our last Number.

"Plate IX. Fig. 1. represents the general construction of the apparatus; *a*, *a*, *a*, is the generator shewn in section. It is a strong cylindrical vessel, made of metal, about three inches thick in every part, which may be a guide to the comparative dimensions of the other parts of the apparatus. ~~This vessel~~ is to be filled with water, and heated by a furnace circumscribing it. On the top of the generator there is an escape-valve *b*, pressed down by the weighted lever *c*, the pressure being adjustable by the shifting of the weight. The valve opens to the steam-pipe *d*, which is to be supposed as proceeding to the working piston of the engine. The lateral pipe *e*, extending from the generator, is merely for the purpose of safety; ~~and~~ at

the end of it there is an apparatus *f*, attached, by which the pressure is indicated; *g*, is the feeding or injecting pipe leading from the forcing pump *h*, which may be worked by a connection to the moving part of the engine.

"In order to generate steam, the vessel *a* must be filled with water, or other fluid or fluids, from the pump *h*, and heated by a furnace, or otherwise; the steam, or escape-valve *b*, being loaded by means of a weight, with a pressure greater than the expansive force of the steam, to be generated from such water, or other fluid or fluids, at the time of its generation. When the water, or other fluid or fluids, in the generator, has attained the necessary degree of heat, say from 400 to 500 degrees of Fahrenheit, more or less, an additional quantity of water, or other fluid or fluids, is pumped into the generator, sufficient to force out a portion of that already heated in the generator from under the weighted-valve *b*, into the steam-pipe *d*, where it instantly becomes steam.

"An enlarged representation of the valve, and its seat, is shewn in the section, Fig. 2. The valve is a spherical bulb, falling into a concave seat, in the lower part of the square chamber; the upper part of the valve is a cylindrical rod, upon the top of which the weight of the pressing-lever is exerted; the lower part of the valve is a triangular stem, sliding up and down in the cylindrical passage. When the additional quantity of water is injected into the generator, by means of the force-pump as described, the bulb of the valve rises from its seat, and a corresponding quantity of heated water passes up between the cylindrical passage and the sides of the triangular stem, into the square chamber, where the pressure, no longer operating upon that portion of the water, it immediately becomes steam, and passes forward through the steam-pipe to the working cylinder.

"In order that the operations may be renewed, and continued regularly, I make use of an adjusting weight on the handle ~~of the~~ pump *i*, which is a small single-stroke forcing-pump, with a weight performing the office of an air-vessel. At the end of the pump-handle is a chain *m*, which I connect with a simple crank movement, and thus, by a corresponding adjustment between the weighted steam, or escape-valve *b*, the throttle-

valve, (which it is not thought necessary to shew in this drawing,) and the weight on the handle of the pump *i*, a certain quantity of water is forced into the generator, at every stroke of the pump, and a corresponding quantity forced from under the weighted valve *b*, to become steam.

" These principles may be modified and applied to the boilers of ordinary steam-engines, a mode of adopting which is shewn in Fig. 3. The invention is here represented under another form, and differently employed, being a plan for heating the water of an ordinary engine-boiler, with a view, principally, to save fuel: *z*, is a tube communicating with the ordinary steam-boiler; *a*, *a*, is the generator, a cylindrical metallic vessel, of which there may be several connected together; these are filled with water as above described, having the furnaces *y*, *y*, under them; *b* is the escape-valve through which the heated water passes; *c*, is the weighted lever pressing down the valve with the required force: *d*, is the chamber and pipe, in which the heated water that escapes through the valve becomes steam, and thence passes through the tube *z*, into the boiler. This boiler (of a cylindrical form with spherical ends) is proposed to be inclosed within a cask or other vessel, and surrounded with pounded charcoal, which material being a very imperfect conductor of heat, is particularly well calculated to preserve the heat of the water and steam within the boiler; *e*, is a pipe, leading from the generator, which is also filled with the heated water; and at the lower end of this pipe there is an apparatus *f*, for ascertaining the pressure of the fluid within the generator. This fluid, by exerting its force at the lower end of the pipe *e*, against the lever connected to a weighing-machine, causes the index to point out upon the graduated dial-plate the number of atmospheres under which the steam is generated. The pipe *e*, being in substance considerably thinner than any other part of the apparatus, is intended to give way, in the event of the pressure within the generator being accidentally raised to a dangerous height; the consequence of which would be, that the pipe *e* would open, and the steam blow out through the fissure, without the possibility of producing any injury; *g*, is the pipe through which the water is injected by the pump *h*,

from the reservoir to the generator; *i*, represents the flue or chimney, from the furnaces below.

"The continued passage of high pressure steam (generated as above) through the tube *z*, heats the water, which occupies about half the interior of the boiler, and by that means a sufficient quantity of steam may be produced in the boiler for working an engine of the ordinary construction, and with a very important saving in the quantity of fuel, compared to what would be consumed, to effect the same purpose, by any other plans heretofore adopted."

"Now, whereas the materials of which my said improvements are constructed, and the exact proportions of the relative parts, are not subjects for which I hereby claim exclusive privilege, though I have described those materials and proportions which I have found most useful; neither do I hereby claim exclusive privilege for the peculiar forms of the various mechanical agents which I employ, but only for a combination of such and the like agents as will produce the said improvements, the nature of which is herein before declared, and for which a claim to exclusive privilege is hereinafter made. *And whereas*, I have only represented in my said drawings annexed, such parts of a steam-engine as comprise my said improvements, the various modes of applying such said improvements, by means of the steam-pipe being too well known to require particular description here. *And whereas*, my said generator may be heated by a variety of known furnaces, I have not described any one in particular, but the one I have used and found to be the best is one of the cupola kind, fed by a blast. *And whereas*, I have described in my said drawing, Fig. 1, a safety-pipe and indicator, and a forcing-pump, neither of which are in themselves new, but which apparatuses, or similar ones, constitute a combination necessary to my said improvements, and are inserted as such; I therefore hereby claim exclusive privilege for the following improvements only: *that is to say, first*—for heating water or other fluid or fluids, for the purpose of generating steam for steam-engines, in a vessel or vessels, kept (during such process of heating) full of such water or other fluid or fluids, and under a pressure greater than the expansive force of the

steam to be generated from such water or other fluid or fluids, at the time of its generation.

"*Secondly*,—For causing such water, or other fluid or fluids, so heated as aforesaid, to escape from under the said pressure, and pass at once from the generator into the steam-pipe, where it becomes steam or vapour, and in that form may pass thence to the cylinder, or to any other situation connected with a steam-engine, without the necessary intervention of any steam-chamber, or other reservoir of steam.

"*Thirdly*,—For the manner of causing such water or other fluid or fluids to escape as aforesaid, that is to say, by forcing other water or fluid or other fluids into the generator, until the pressure against the steam-valve shall cause it to rise, the valve being so loaded as not to rise, except by means of such extra pressure as aforesaid.

"*Fourthly*,—For the general application of such water, or other fluid or fluids, so heated as aforesaid, and of the steam or vapour generated thereby; whether such steam or vapour be employed through a steam-pipe without a steam-chamber or reservoir to act immediately on the piston, or to be collected in a reservoir or steam-chamber, and thence to act on the piston, or only for heating water to generate other steam, or for any other purpose or purposes whatsoever, provided always, that such general application as aforesaid be for the purposes of steam-engines."

The Editor of the London Journal of Arts, from which we have taken the preceding specification, informs us, that the mode of applying this principle to a variety of operations in which heating may be requisite, is embraced by a second patent to be specified in November, and that the mechanical construction of the working parts of the engine will be explained in the specification of the third patent, which will be enrolled in December.

The same writer informs us, that several of the new engines which have been ordered, are at present constructing; and, particularly, that an engine of about 80-horse power, for the purposes of steam navigation, is in considerable forwardness, and will probably be in operation between London and Margate before the end of the present summer.

PERKINS'S IMPROVEMENTS ON STEAM ENGINES

Fig. 1.

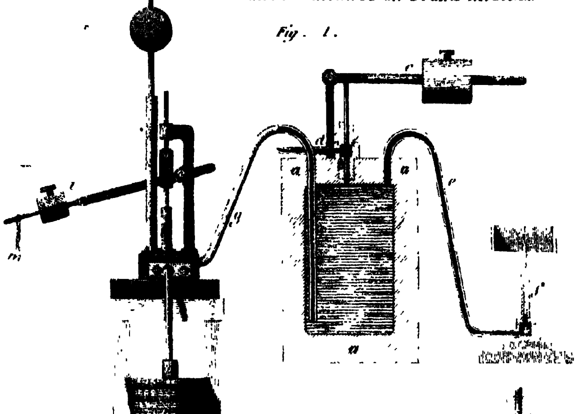
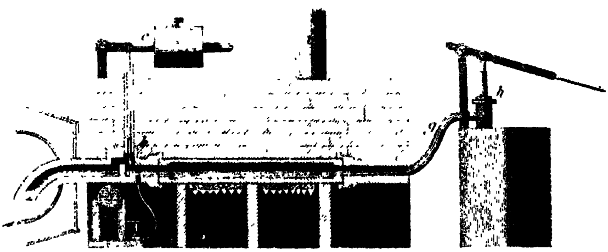


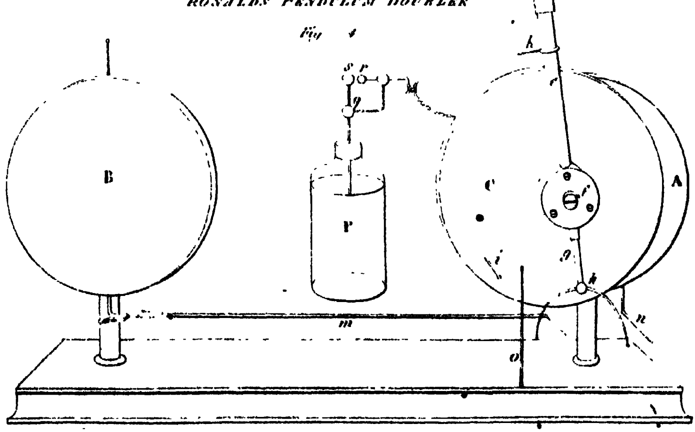
Fig. 2.

Fig. 3.



RONALDS' PENDULUM DOUBLER

Fig. 4.



Edin.r Published by A. Constable & C.o 1823.

ART. XXIII.—*Mineralogical Description of some Aërolites which fell near Wiborg, in Finland.* By NILS NORDENSKIÖLD, Esq. M. G. S.

IN the *Algemeine Nordische Annalen der Chemie* of Scheerer, Part I. p. 174, there is given a short account of the circumstances connected with the fall of certain meteoric stones, on the 13th December 1822, near Loutolox, a village in the parish of Savitaipal, in the Government of Wiborg, in Finland. A short mineralogical description of these substances may perhaps be of some interest, even without a complete chemical analysis, more especially as I am not aware that any meteoric bodies of this nature have hitherto been observed to fall in so high a latitude.

In external appearance, they have more resemblance to lava than to any other stone I have had occasion to see. The surface, as usual, is covered with a black shining crust, but, when broken, it presents the appearance of an aggregation of volcanic ashes, and it is so friable as to be easily reduced to powder by the fingers. The following ingredients can be very easily distinguished in it.

1*st*, A greenish transparent mineral, which looks as if it had been melted, and under the blowpipe exhibits the same phenomena as olivine. The largest globules of it are not greater than a pin's head.

2*dly*, A white semitransparent mineral, which has often a crystalline appearance on the surface, and which exhibits no marks of fusion when inspected with the microscope. It is so very friable that it is difficult to get a bit of it for examination.

By itself it is quite infusible, and under the blowpipe still retains its translucency. With soda, it gives only a scoria, which is very difficult to fuse; with borax, it melts with difficulty into a clear and colourless glass; with salt of phosphorus it unites with still more difficulty, and the globule turns opake on cooling; solution of cobalt gives it a blue colour, but it does not fuse.

These experiments, it must be confessed, are not altogether sufficient to determine with certainty its precise nature; but under this treatment it exhibits exactly the same phenomena as leucite, which mineral it closely resembles in external aspect.

3dly, Some few metallic grains could be extracted with the magnet. These were examined, in order to find if nickel existed in them, but none could be traced.

4thly, The great mass of the stone was a greyish ash-coloured powder, with very little cohesion. Under the blowpipe it presented the following changes:

It melted, without intumescence, into a black opake glass; with borax, it melted with difficulty into a glass of a deep iron-colour; with salt of phosphorus, the glass left a skeleton of silica, and was coloured with iron; with soda, in small quantity, it gave a black globule; if a greater quantity of soda was used, part of it went into the charcoal, and left a dark-brown unmelted scoria.

These circumstances show that aërolites ought to be regarded and examined, not as homogeneous masses, but as a kind of compound rocks. Like other rocks of this description, they contain minerals of very different kinds, but commonly in a very minute state of division. The grey powder, which approaches more nearly in appearance to volcanic ashes than to any other substance, contains perhaps the rudiments of minerals which have not yet had sufficient time or quietness to crystallize, or of which the crystals are so minutely mixed that we are not able to distinguish them from one another. This sufficiently accounts for the differences of proportion between the constituent parts of aërolites that have been analysed.

Art. XXIV.—*Observations on Double Stars.* By M. Struve, of Dorpat, and Professor Amici, of Modena.

M. Struve, an able and active astronomer at Dorpat in Livania, conceived the very laborious design of making a new catalogue of all the Double Stars which were observed about forty years ago, by Sir William Herschel,—to compare these observations with his own, and especially to examine if any change had taken place in the relative positions of the two stars.

M. Struve has published the results of part of this laborious undertaking, in his collection of Astronomical Observations; but as we have not seen that valuable work, we have taken the following abstract of it from Baron Zach's *Correspondance Astronomique.*

1. *μ Cassiopeia.* R. Asc. 0h 38′. Decl. 56° 51′ N.
Greatest star, 4th Mag. *Least*, 8. 9th Mag.

In 1814, M. Struve found the difference of Right Ascension of the two stars to be 1″.14, the Angle of Position 16°.7, and consequently the Distance 9″.7. Sir W. Herschel had found their distance in 1779 to be 11″.275, and the angle of position 28° in that year, but only 19°.3 in 1803. In 1818 and 1819 M. Struve found the difference of right ascension to be 1″.3, and the angle of position 9°.8 N. following. Hence their distance in 1819 is 10″.82, and the difference of declination 1″.84. The diminution of the angle of position is therefore positively ascertained, having varied as follows:

In 1782.5 . .	= 27° 56′	*Sir W. Herschel.*
1803.1 . .	= 19° 14	*Ditto.*
1814 . .	= 16 7	*Struve.*
1819 . .	= 9° 48	*Ditto.*

2. 66. *Whale.* R. Asc. 2h 3′. Decl. 3° 17′ S.
6th and 9th Magnitudes.

	Struve:	Herschel.
In 1819 Diff. of R. Ascension,	0″.842 1781	
Diff. of Declination,	0.8	
Distance, . .	16.15	16″875
Angle of Position, .	38°.40	

3. *λ Auriga.* R. Asc. 5h 6′. Decl. 39° 58′ N.,
6th and 10th Magnitudes.

1819 Diff. of R. Ascension, .	5″.105
Diff. of Declination, . .	1.55

4. *Castor.* R. Asc. 7h 23′. Decl. 32° 17′ N.
3d and 4th Magnitudes.

The large star is yellowish-white, and the small star bluish-white.

1813,	Angle of Position, - -	2° 52
	Difference of Declination, -	0.″21
	Distance, - - -	5°.6
1819,	Difference of R. Ascen., -	0.″424
	Angle of Position, - -	—0° 4′
	Distance, - - .	5″.18

Sir W. Herschel found the distance in 1778 to be 5″.156.

		Angle of Position.
In 1759,	- - -	56.°52 *Bradley.*
1779,	- - -	32. 47 *Herschel.*
1803,	- - -	40. 43 *Ditto.*
1813,	- - -	2. 53 *Struve.*
1819,	- - -	0. 24 *Ditto.*

5. γ. *Lion.* R. Asc. 10h 0′. Decl. 20° 45, N.
2.3 Mag., and 4th Mag.

M. Struve considers the large star as reddish, bordering on yellow, and the smaller as of a green colour; while Sir W. Herschel calls the first white, and the second reddish. In 1819, M. Struve found the difference of R. Asc. to be 0h.262, and the distance 3″.74.

In 1782, Angle of Position, =		7°.37 *Herschel.*
1823,	- - -	6 .21 *Ditto.*
1820,	- - -	10 .32 *Struve.*

6. ξ. *Great Bear.* R. Asc. 11h 9′. Decl. 32° 33′ N
4.5 Mag., and 6th Mag.

In 1819, M. Struve found the difference of R. Asc. to be 0″.212, and the distance 2.″73.

		Angle of Position.
In 1781.97,	- - -	306° 13′ *Herschel.*
1802.10,	- -	352 29 *Ditto.*
1804.08,	- - -	357 22 *Ditto.*
1819.10,	- - -	165 27 *Struve.*
1820.13,	- - -	173 39 *Ditto.*

Consequently, in 38⅛th years, the small star has performed 227° 26′ of its revolution round the great one, in an apparent orbit of great ellipticity, as may be conjectured from the different velocities of its motion. For,

	Motion.	Mean Annual Motion.
From 1781.97 to 1804.08 =	51° 09′	2° 18′
1804.08 1820.13 =	176 17	10 59

Hence we may conjecture that the star performs a revolution in 60 years.

7. 83. *Lion.* R. Asc. 11h 18. Decl. 4° 0′ N.
6.7 Mag., and 7.8 Mag.

In 1780,	Angle of Position, =	55° S. Foll.	*Herschel.*
1802,	Angle of position,	62°.05	*Struve.*
	Distance, -	30″	*Ditto.*

8. *γ Virgin*, R. Asc. 12h 33′. Decl. 0° 27.

3d Mag. and 3d Mag.

1756.0	Angle of Position	= 54° 22′ N. Foll.	*Mayer.*
1781.9	- -	40 44	*Herschel.*
1803.3	- -	30 20	*Herschel.*
1820.2	- -	15 15	*Struve.*
1819	Diff. of R. Asc.	0″.239	*Struve.*
1820	Distance,	3 .56	*Struve.*
1780	Distance,	5 .7	Calculated from Mayer and
1756	Distance,	6 .5	Herschel's observations.

Baron Zach and M. Struve propose to determine the distance of these stars from their occultation by the moon.

9. 44 *Bootes*, R. Asc. 14h 58′. Decl. 48° 21′ N.

6th Mag. and 7th, 8th Mag.

Both these stars are white, and very difficult to be seen on account of the smallness of their distance.

In 1781.6	Angle of Position	30° N.	Following.
1819.0	- -	42 S.	Preceding.
1819	Diff. of R. Asc.	0″.88	

Hence the angle of position has changed 168° or 192°. A third observation will shew if one of the stars has performed more than one revolution in 38 years.

10. *σ Northern Crown*, R. Asc. 16h 8′. Decl. 34° 20′ N.

4th, 5th Mag. and 7th Mag.

The largest star is white, and the smallest dull.

Their distance is 2″.2, which is a little doubtful. The difference of declination is 0″.73.

In 1781.8 the Angle of Position was	77° 32′	N. preced.	*Herschel.*
1802.7* - -	78 36		*Do.*
1819.6 - -	40 0		*Struve.*

11. *ζ Hercules*, R. Asc. 16h 34′. Decl. 31° 56′ N.

In 1781 Sir W. Herschel saw the two stars very distinctly. Afterwards he could only observe, with very high magnifying powers, one of them, which was of a conical form. M. Struve has never been able to see this star double; but it will no doubt again appear so.

12. 1 *ψ Dragon*, R. Asc. 17h 45′. Decl. 72° 14′.

It appears from the observations of 1815, that these stars

have not approached one another. A comparison of the observations of Bradley and Piazzi does not shew that any change has taken place.

13. *η* 70 *Serpentarius*, R. Asc. 17h 56′. Decl. 2° 34′.
4th Mag. and 7th Mag.

The largest of these remarkable stars is yellowish, and the smallest red.

In 1779.77	The angle of Position was		0° 0′	*Herschel.*
1781.73		-	9 14	*Do.*
1804.41		-	131 19	*Do.*
1819.63		-	281 18	*Struve.*
1820	February 16.	.	288 58	*Do.*
1818	Distance,	-	5 .34	*Do.*
1819	Distance inferred,	-	1 .05	*Do.*

years.

Hence, in 39.86, the small star has moved through three-fourths of its orbit, and it is very probable that it will complete its revolution in ten years more. The apparent orbit of it seems to be very elliptical.

14. *θ Serpent.* R. Asc. 18h 48′. Decl. 3° 58′ N.
5th Mag. and 5th Mag.

Both stars are white, and one a little smaller than the other.

In 1755, the Diff. of R. Asc. was		21″.0	Diff. of Decl.	6″.1	*Bradley.*
1778,	. .	21. 0	.	6.2	*Ch. Mayer.*
1819,	. .	22. 5	.	5.5.	*Struve.*

15. 2. *c.* 16. *Swan.* R. Asc. 19h 37′. Decl. 50° 6′ N.
6th Mag. and 6th Mag.

Both stars are white, the following one being the smallest:

In 1755,	Diff. of R. Asc. 34″.40	Diff. of Decl.	26″.6	*Bradley.*
1819,	. 41 .25	.	28 .0	*Struve.*
1819, Distance,	. 38 . 5.			
1819, Angle of Position, 46° 36′ S. Fol. *Struve.*				

16. 61. *Swan.* R. Asc. 20h 59′ Decl. 37° 52′ N.
5th Mag. and 5th and 6th Mag.

The larger star is yellow, and the smaller one a deep-red. The relative motion of these stars was discovered by M. Piazzi, in 1804. M. Bessel examined them in 1812.

In 1819, Angle of position was 6°. 58′ N. Fol. *Struve.*					
1819, Distance,	.	15″.2			
1812.3 Diff. of R. Asc.		19 .8	Diff. of Decl.	13″.20	*Bessel.*
1819.9	. .	19 .1	. .	1 .85	*Struve.*

Hence the difference of declination of these stars has diminished in 7.6 years.

M. Struve has likewise published his observations on 68 Double and Multiple Stars, which we hope to be able to lay before our readers in next Number.

In a subsequent article in Baron Zach's *Correspondance*, he has given an account of some observations on Double Stars, made by M. Struve with a new micrometer, constructed by M. Frauenhofer of Munich. These observations are highly interesting both in themselves, and as shewing the great accuracy with which this class of observations may be made with good instruments.

α *Hercules.*

Distance.	
1822, Aug. 26.	4″.94
27.	5 .31
31.	5 .14
Mean,	5″.13

ρ *Hercules.*

Distance.	
Aug. 26.	4″.60
27.	4 .51
31.	4 .15
Mean,	4″.42

95. *Hercules.*

Distance,	
Aug. 27.	6″.53
Sept. 20.	6 .55
Mean,	6″.54

5. *Eagle.*

Distance.	
1822, Aug. 24.	13″.13
Sept. 22.	13 .42
Mean,	13″.27

ξ *Great Bear.*

Aug. 31.	14″.79
Sept. 2.	14 .69
Mean,	14″.74

61 *Ophiuchus.*

Aug. 26.	20″.17
Sept. 2.	20 .54
20.	20 .71
Mean	20″.47

15. *Eagle.* Distance.

1822, Aug. 24.	31″.68
Sept. 22.	31 .64
Mean	31″.66

The following are measures of the differences of declination, of the double star γ *Arietis*, with the same micrometer.

1821, Nov. 9.	Nov. 28.	Dec. 12.	
9″.26	9″.18	9″.08	General Mean, 9″.0.6
8 .84	9 .26	9 .50	
8 .94	8 .94		
8 .68			
Mean, 8″.93	Mean 9″.13	Mean 9 .29	

Difference of declination of the double star ι of Cancer.

1822, Feb. 21.	Feb. 25.	Mar. 19.	Mar. 26.	
4″.82.	4″.62.	5″.00.	4″.58.	General Mean, 4″.85.
5 .04.		4 .86.	5 .04.	
Mean 4″.93.		Mean 4″.93.	Mean 4″.81.	

The following observations were made by Professor Amici of Modena, by means of a micrometer of his own construction.

Names of the Stars.	*Distances.* Amici.	*Distances.* Herschel.
ξ Bootes, . .	6″.40‴	3″.23‴
α Hercules, . .	4 .24	4 .34
π Bootes, . .	6 .12	6 .171
γ Virgo, . .	3 .18	7 .333
ζ Great Bear. .	13 .16	14 .5
β Swan, . .	33 .8	39 .32

In the years 1800 and 1801, M. Triesnecker measured by means of a Dollond's divided object-glass micrometer, the distance of the two stars in ζ of the Great Bear, and obtained 15.″4 as the mean of 41 observations, which agreed to the fraction of a second. Baron Zach has calculated the distance at 16″.009, from Piazzi's first Catalogue for 1800; and M. Struve computed it at 15″.91, from Piazzi's second Catalogue.

The following Table, abridged from that of Baron Zuch, contains a comparison of the observations of Sir William Herschel and M. Struve, on a number of double stars, not given in the preceding paper.

TABLE of the Distances of several Double Stars, according to the Observations of Sir William Herschel and M. Struve.

Names of the Stars.	Magn.	For 1823. R. Ascen. in Time.		For 1823. Declinations.		Distances. Struve, in 1819.		Distances. Herschel, in 1782.
18 α Cassiopeia, -	3	0h	31′	55°	34′ N	58″,	80	53″
65 Pisces, - -	6	0	40	26	44 —	5,	77	—
α Polaris, - -	2	0	57	88	22 —	18,	27	17
57 γ Andromeda, -	2	1	53	41	29 —	10,	48	9
Mira, - - - -	2	2	10	3	47 —	114,	25	—
30 Aries, -	7	2	27	23	52 S	38,	26	31
η Perseus, -	4	2	38	55	9 —	28,	50	26
48 σ Orion, - -	4	5	30	2	43 N	13,	60	11
13 σ Great Bear, -	5	8	55	67	52 —	7,	19	8
38 Lynx, - -	4	9	8	37	33 —	5,	08	—
23 h Great Bear, -	4	9	17	63	50 —	21,	64	19
12 Greyhounds, -	3	12	48	39	17 —	19,	87	20
21 ι Bootes, -	4	14	10	52	11 —	38,	55	37
39 Bootes, -	6	14	44	49	27 S	5,	00	—
15 ξ Balance, -	6	14	47	10	41 —	9,	31	—
7 ζ Northern Crown,	4	15	33	37	13 N	7,	25	5
γ Hercules, -	3	16	14	19	35 —	40,	80	42
17 Dragon, -	5	16	32	53	17 —	4,	19	—

TABLE of Distances—continued.

Names of the Stars.	Magn.	For 1823. R. Ascen. in Time.		For 1823. Declinations.		Distances. Struve, in 1819.		Distances. Herschel, in 1782.
121 μ Dragon, -	5	17h	2′	54°	43 N	4″,	19	4″
64 α Hercules, -	3	17	7	14	36 —	5,	61	5
75 ρ Hercules, -	4	17	18	37	19 —	4,	78	3
61 Serpentarius, -	6	17	36	2	41 —	20,	44	19
95 Hercules, -	4	17	54	21	36 —	7,	04	6
59 d Serpent, -	6	18	18	0	6 —	3,	76	—
4 ε Lyra, -	5	18	38	39	29 —	3,	83	—
5 Lyra, - -	6	18	38	39	26 —	3,	43	—
11 Eagle, -	6	18	51	13	24 S	21,	35	7
20 η Lyra, -	6	19	8	38	51 —	28,	30	26
6 β Swan, -	4	19	24	27	36 —	35,	96	40
4 ε Arrow, - -	5	19	29	16	4 —	91,	50	92
16 c Swan, -	5	19	37	33	45 —	38,	51	30
Altair, - -	1	19	42	8	24 —	139,	10	143
1 κ Cepheus, -	5	20	22	77	12 —	7,	08	6
15 Dolphin, -	6	20	23	10	46 —	14,	50	12
52 Swan, - -	6	20	38	30	5 —	7,	69	—
12 γ Dolphin, -	3	20	39	15	30 —	12,	54	10
1 ε Little Horse, -	5	20	50	3	37 —	11,	35	9
Swan, 296 Bode, -	6	21	0	46	57 —	15,	20	18
8 β Cepheus, -	3	21	26	69	47 —	13,	31	13

Art. XXV.—*Journal of a Tour to the Coast of the Adriatic Sea, and to the Mountains of Carniola, Carinthia, Tyrol, Saltzburg, and Bohemia, undertaken chiefly with a view to the Botany and Entomology of those countries.* By Dr David Henry Hoppe and Dr Henry Hornschuch. (Continued from vol. ix. p. 94.

" *Hundsberg, April* 11.—THE wood of Lippiza had so many attractions for us, that we unanimously agreed to visit it early again to-day. We proceeded thither immediately after we had breakfasted; and, in order to avoid the inconveniences of the stony plain, and those of the *barrière*, we made our way directly through the village of Bassowitza, and thus came without difficulty, after a good quarter of a stund's walk, into the wood, by the same spot through which we had quitted it the day before yesterday. While we were looking for our two spe-

cies of *Crocus* we found the *Cr. variegatus* in flower, plentifully along the inside of the wall, in a most beautiful state. We resolved to collect specimens of this on our way back, and began to search the wood most carefully, that no spot might be left unexplored. We observed many hollows, and many rocky places, in the clefts of one of which, in a very sheltered situation, we found the *Scolopendrium officinale* in abundance; also leaves of *Lamium Orvala, Veratrum nigrum, Convallaria (majalis)*, and large plants of a species of *Conium*. The mosses were so parched and dry, that *Hypnum alopecurum* alone could be recognised. *Anemone pulsatilla*, and *Globulariæ*, covered the ground in glorious profusion; but the *Erythronium* and *Isopyrum* were not to be seen anywhere, except in the hollow places which are at about a hundred yards distance from the Mews, on the left-hand side. We found nothing else that was new to-day; most of the plants being also but just beginning to appear." "After we had climbed some walls by Bassowitza, on our return, we arrived at some green spots, everywhere about which grew *Hyacinthus botryoides, Crocus variegatus*, and *Fritillaria Meleagris;* the latter only shewing the flower-buds."

Our travellers, the next day, met with much civility from M. Grünling, a Vienna merchant, who is described as being both a draughtsman and naturalist; and this circumstance gives occasion to the motto prefixed to the next letter, quoted from Villars, "*La botanique vous procurera partout des amis, et des connoissances agréables.*" Mr Grünling offered to one of the gentlemen a passage in a boat which he had hired to convey himself and a friend to Pola, which was gladly accepted.

"*Pirano, April* 13.—This morning at one o'clock we rowed out of the harbour of Trieste, our little boat being stocked with all kinds of provision, a precaution which, necessary in all sea-excursions, is never more so than in a voyage to Istria, where there are no inns, not even in the principal towns. This country is destitute of trade, its very few productions of oil, &c. being always conveyed away by water.

"The wind at first was extremely unfavourable, and the whole sea covered with a fog, which prevented any view. At day-break, as we were informed by some vessels which we met, we

were off Capo d'Istria. However, as the wind soon improved, we sailed tolerably fast along Isola and Pirano, and had nearly reached the Punta di Salvora, when such a violent sirocco blew against us, that we were obliged to put back, and cast anchor in the haven of Pirano. We landed near that house where the Ex-King Jerome had slept when he fled from Trieste. As it was now dinner time, we had some sand-eels fried in oil, which fish are here caught in great quantities; and I also took this opportunity to explore the country. Vegetation is much more advanced here than at Trieste, and I found *Coronilla Emerus* plentifully in flower, also *Ophrys arachnites, Polygala vulgaris* with very large inflorescence, and *Carex Schœnoides* of Host. The insects were *Carabus purpurascens*, and *Crecopis sanguinolenta*. Towards evening we proceeded to the city; on the road grew *Rubia tinctorum, Vinca major*, and *Silene noctiflora*. We arrived at the town just in time to witness a scene which is common in this country, the distribution of the water. In a small square a reservoir is erected, into which the troughs from all the neighbouring houses convey the rain-water; the whole resembles a well, only that it is quite covered in and locked. At a particular hour of the day, the door is opened, and a certain quantity of water is distributed to each inhabitant. From such occurrences as this, we are taught to value the happiness of those countries where Nature diffuses the crystal element in never-failing springs.

"The wind continuing unfavourable, and the sea being very rough, we shall find it impossible to prosecute our voyage, if appearances are not improved this evening."

"*Città Nuova, April* 14.—We left the harbour of Pirano yesterday evening, about nine o'clock, amidst the singing of the nightingales; and although we were obliged to cast anchor sometimes, during the night, on account of the heavy rain, we arrived here about nine o'clock this morning, when our sailors all attended high mass, it being Easter. The air is clear today, and the coast of Istria presents a very beautiful view. The noble olive-woods, and the forward state of vegetation, are particularly striking to the eye of a German botanist, who can also gratify himself here with the noble prospect of both sea and land together. On the right and left are seen hills clothed

with olive-grounds and vineyards, which extending far eastward, seem, as it were, to melt into the high mountains that close the scene to the northward, and between these extends a beautiful valley, planted likewise with these useful trees."

"*St Servero, April* 14.—After we had taken a frugal dinner at Città Nuova, in the house of a shoemaker, who had been with the French at Berlin, and had there learned a little German, we sailed onward with a rather more favourable wind. But we had scarcely been an hour at sea, when a dreadful sirocco again arose, which dashed our little bark to and fro with such violence, that the few goods within it were thrown about, and even the stove was upset. The captain declared that he would not sail to Parenzo, which lay directly before us, and was not more than two stund distant, for 1000 ducats; and that we might consider ourselves fortunate if we reached the nearest bay in safety. This he averred with so much earnestness, and his declaration was so entirely seconded by the waves, which threatened every moment to swallow us, that we made no opposition to his wishes, and in half an hour we safely attained the bay, and cast anchor there. It rained incessantly; and as there was only a little hut on the shore, wherein stood a guard of soldiers, which were posted to prevent the landing of persons from vessels under quarantine, we were compelled to pass the night on board, and wait patiently the happy hour when the sirocco should abate, and a more favourable wind arise, to convey us forward on our voyage.

"*Parenzo, April* 15.—As the storm still continued, and gave no immediate prospect of a change, we determined to land in the morning and come hither on foot, in order to inquire if we could not proceed on our journey by land. A soldier accompanied us to the health-office, where we inquired the way to Pola. We were told, that, with horses, we might make the journey in one day; but we were advised not to attempt it, as the road was extremely insecure, and we could not travel two stund without risking an attack from robbers. This declaration was confirmed at the Commissariat's of the Police; and we determined to request the protection of the Lieutenant, which was granted to us with much civility. But now a fresh difficulty arose; there was not a horse to be had in the city, nor could any

be procured from the country till 4 o'clock in the afternoon, nor even then without the aid of the military. This would have induced us to perform the distance on foot, but the continual rain prevented this intention, and we determined to stay where we were for the night, and if the wind did not change in the morning, to send one of our companions back to Trieste, while we should yet await a fair wind and proceed to Pola by water. In order to lose no time, one of our companions, M. Bruckner, made his agreement to-day with a captain of a vessel, and procured his passport, so that, in case the wind should not change to-morrow morning, he might depart without any delay. The guard at the health-office prepared a dinner for us, and received us into his house, as there are no inns here, and our boat lies at two stund distance from the town. In the afternoon we saw the church, some Roman antiquities, and the tower, in company with the amiable young Marquis Pollissini. On account of the incessant rain, we resolved not to go on board, but to remain in the city. Here the Austrian Lieutenant visited us, accompanied by a pensioned French captain, and we passed the evening very agreeably.

" *Pola, April* 16.—Our companion M. Bruckner, left us this morning early, and commenced his voyage back; but in an hour after the wind changed and came to the north-east, (Tramontani.) At 9 o'clock our captain appeared, and informed us that his ship was ready, and that we had better sail. We fetched our passes, breakfasted immediately, and went on board, and in half an hour sailed out of the harbour of Parenzo.

Parenzo is a small town, of about 2000 inhabitants; and viewed from the sea, it has a very pretty appearance, but when more closely inspected it looks but ill, consisting of miserable houses, narrow, dirty, and crooked streets; and except some coffee-houses, it does not contain one place for the entertainment of strangers. On account of the ceaseless rain, we had passed the greater part of the day in the coffee-house at Nobili, where we heard from a former Vice-Prefect of Istria, whom we met there, a not improbable reason for the present insecure state of this country. According to his idea, this does not arise from the poverty, but from the great laziness of the natives. " The Istrian," said this gentleman, " lives but from one day to another,

and only works for as much as shall maintain him for that day; and the want is, consequently, as great in years of plenty, as it is in those of scarcity; for, if he has something, he idles away his time till it is all expended, and then endeavours to live at the expence of others. If he was more industrious, it would be easy for an inhabitant of this country to obtain some independent property, for the soil would richly reward his labours, and navigation presents him with a most favourable opportunity of selling his productions at the neighbouring ports of Trieste or Venice. But his disinclination for labour, rather leads him to beggary and thieving, which is the reason why the government should compel him to labour, and severely punish every act of robbery. This, alas! is not the case; and, therefore, the more industrious individual is prevented from improving the cultivation of his land; for another will steal from him his wood, and suffer the sheep to devour his crops, which is frequently done without being followed by any punishment. The beneficial effect of a rigorous government was plainly seen here, when the French declared Istria outlawed, and severely and instantly visited every delinquency with chastisement. At that period, a person might travel through the country with money in his open hand, without running any risk of having it taken from him by robbers, whilst under the present inefficient laws, there is not an hour's security.

"The country about Pirano is beautiful; the hills are clothed with bushes of evergreens, among which grow *Ruscus aculeatus* and *Asparagus acutifolius*. I was much mortified at being prevented by the heavy showers from botanizing in this neighbourhood, as I had promised myself a rich harvest; and even yesterday, when in our way from the ship to Parenzo, I had noticed a whole wood, consisting of a *Carpinus*, which was unknown to me, whose rose-coloured catkins delighted us exceedingly. This we intended to gather on our return, but unfortunately we did not go back that way, and therefore are deprived of it.

"When we quitted Parenzo, the Island Sancto Nicolo, which is planted with olive trees, lay off to our right hand; here the vessels which arrive from suspected places must perform quarantine; and here, it is said, grows a shrub which the master

of an American ship brought with him from that country, and which having been planted on this island, thrives remarkably well. The bad weather prevented me from taking a more close inspection of this shrub. As the wind was favourable, we sailed very swiftly past the noble coast, and the high towering hills which were at a considerable distance inland. The shore is covered with delightfully scented bushes, whence was continually heard the lay of the nightingale. We soon reached Fontana and Orsero, two insignificant places. Here is obtained the beautiful white limestone, which is quarried in large masses, and sent to Venice for building. Near Orsero, the Canal Limo runs far into the country. About 12 o'clock we reached Rovigno, a town of about 12,000 inhabitants, situate on a peninsula of land, which has a double haven, and yet is not well secured from the wind. The town, for the distance of a stund, is entirely inclosed with noble olive trees. Here we were compelled to steer between numerous crags, covered with shrubs, whilst the shore itself consists of sharp rocks, which makes the landing very dangerous when the waves are high. From hence the coast is uniformly flat, and, as there is no village, if you except some insignificant dwellings, so the land appears quite uncultivated. The bushes which clothe the hills extend their perfume for three or four stund across the sea, and when you approach nearer, you are greeted with the melody of Philomel. We soon passed Fasana, and saw Peroi some miles into the country. It is a village inhabited by an unmingled race of Greeks. We then reached Stignano. From Peroi to this last named place you sail between the coast and two considerable islands, whose verdant shrubs fill the air with balsamic fragrance, whilst the inhabitants, praising the bounty of their Creator, make known his goodness in melodious songs. Never in my life have I enjoyed a more delicious evening than this. The wind was hushed, the sea quite calm, the sky perfectly clear, the air soft, filled with the harmony of birds, and loaded with perfume, the shore covered with underwood, growing in the greatest luxuriance, along which we slowly glided. A deep silence prevailed, which was interrupted only by the splashing of our oars. In short, the whole effect was such as might have led us to conclude that

we were moving in other and happier regions, and we enthusiastically sang Goethe's *Praise of Italy*.

"Near Stignano we again, for a short time, quitted the coast for the open sea, in order to sail round a rock; and we then ran into the noble haven of Pola. It was in the evening, and, for the first and last time, we beheld the beautiful amphitheatre of this place in the greatest perfection, gilded as it was by the rays of the setting sun. As the Bay of Pola is very extensive, we were obliged to make many tacks before we could come to an anchorage, and thus we obtained several views of the town and its neighbourhood, each more beautiful than the other. In about an hour we landed, showed our passes, and having proved that we came from no infected place, we inquired for a lodging. They informed us that there was not a single inn at Pola, but they directed us to people who let lodgings. Here we found a commodious apartment, good beds, and civil people; we therefore immediately got our goods from the vessel, and took up our quarters.

"*Pola, April* 17.—Our first walk this morning was to the amphitheatre, which struck us with awe and astonishment, and gave us occasion for many reflections. We then visited the temples of Augustus and Diana, the first of which has been completely cleared of the stables and sheds which had surrounded it, whilst the latter is almost entirely hidden; but this will not long be the case, as people are already employed in removing its unworthy neighbours. We also visited the Porta Aurea, as the temple, which was the beautiful memorial of female affection, is called; and we were sorry to observe, that both the corroding teeth of time, and the swifter progress of human destruction, had been too evident here. After dinner, we proceeded again to take a closer view of the amphitheatre, my friend Mr Grünling to study *it* alone, and I to seek also in its vicinity for the treasures of Fauna and Flora. I found, to my great joy, the beautiful *Anemone hortensis* growing in considerable abundance under the bushes, in a fine state of bloom. I immediately dug up several specimens, and determined, that just before my departure for Trieste, I would return for others, as I wished to carry them thither in a fresh state, having no press for drying them with me. As I did not find any thing else in-

teresting among the plants upon these dry hills, I sought about for insects, and particularly investigated the many heaps of dung that I saw, promising myself from thence a numerous catch. By this extraordinary conduct I attracted the attention of the passers by, who all, in various modes, testified their surprise; and, in particular, an aged ecclesiastic seemed struck with astonishment, and, after attentively watching my mode of entrapping and examining my prey, he departed, frequently looking back and shaking his head. I found in great plenty *Copris Lemur* and *Capra*, and *Ateuchus Schoëfferi*; more rarely *Copris Cænobita*, *Scarabæus vernalis*, *Aphodius quadrimaculatus*, *hæmorrhoidalis*, *Sus*, *terrestris* and *conflagratus*, and *Copris Bison*. Under stones I discovered *Nebria?* and *Silpha lævigata*. We returned home to our lodging only when night drew on, after having witnessed the reception of the Governor Rosetti from Trieste, whom the Magistrates of Pola went as far as the Amphitheatre to meet, amid the general ringing of bells and thundering of cannon.

" *On the Adriatic Sea*, *April* 18.—We visited, early to-day, the old castle, which is situated on a hill close to the eastern part of Pola; and of whose walls and ramparts, since Mars has quitted them, Flora and her train have taken possession. On our road thither, we picked up an injured specimen of *Ateuchus pius*. The ramparts, and the space within the inclosure, were entirely overgrown with *Artemisia Absinthium*; and the well was full of *Scolopendrium officinale*, and *Adiantum Capillus Veneris*. These, however, the depth of the well would not permit us to reach. From the castle, we proceeded to the amphitheatre; and I botanizing, found in the way, and near the place, *Lathyrus Nissolia*, *Hesperis verna*, and *Vinca minor*; also *Ophrys arachnitit*, and *Ornithogalum umbellatum* in full flower. I also got a beautiful specimen of *Ateuchus pius*, which pleased me the more, as we had provided ourselves, even at Gefrees, with a large box on purpose for the reception of this beetle. Returning, I explored the city walls, and was repaid by abundance of *Fumaria acaulis*, *Antirrhinum Cymbalaria*, and *Geranium rotundifolium*; and here likewise, as in all parts of Istria, I observed the *Parietaria judaica* growing in large quantities. After dinner, we went, in our bark, to the new castle Santo Andrea, which is situated on

an island, and protects the double entrance to the haven. We had intended to botanize there; but a flock of sheep, which we had, from a distance, observed, and who, with their shepherd, were the only living inhabitants of the spot, warned us to expect but little success, which a closer inspection confirmed. On the whole island, we did not find a single plant, except some poor specimens of *Alyssum montanum*; and we therefore hastened to the more promising Scolio d'Olive. Here we had better success. *Phyllyrea media*, *Pistacia Lentiscus*, and *Laurus nobilis*, formed, together with less interesting shrubs, several hedges, and these were beautifully in flower. Under them grew *Arum italicum*, *Rubia tinctorum*, and *Asparagus acutifolius*. Vegetation had already assumed a perfectly Italian character. Within the blossoms of the *Phyllyrea media*, were some individuals of *Curculio Gorzensis*. If time had permitted, we would willingly have investigated the adjacent hills, which were overgrown with *Laurus nobilis*; but evening had approached, and I had yet to fetch the *Anemone*; so that we were reluctantly obliged to return to the city. As soon as we arrived there, I set off to get the Anemone, and it was quite dark before I reached home. We then obtained our passes, invited the Secretary of the Police to supper, and at midnight embarked. The weather was beautiful, but the wind too low to permit of our making much progress. We therefore cut slowly through the waves, but listened with pleasure, to the plaintive chaunt of several nightingales, which some of the young fellows belonging to the vessel had procured to carry as presents to their fair ones. Then, bidding a cheerful farewell to Pola, and its delightful territory, we surrendered ourselves to the power of sleep.

" *Rovigno, April* 19.—At day-break we were some miles beyond Fesano; and, at noon, landed at Rovigno, where our sailors were at home, and where we anchored till the evening, at which time a strong wind generally rises. We went into the city, which looks grandly from a distance; but we found the streets narrow and dirty, and the inhabitants yet more filthy; the female sex particularly distinguished by their disgusting want of cleanliness. The doubt might be very pardonable which suggested itself to our minds, and which made us question whether the individuals seated before the doors and employed in spin-

ning net-yarn, or in weaving nets, really belonged to the fairer half of creation, so little did there appear, in their manners, either modesty or cleanliness, those distinguishing traits of the female character. The wildly disordered state of their hair, which hung loose and uncombed upon their backs and shoulders, and wherein they mutually and amicably hunted for its noisome inhabitants, accompanying this action with the loudest and most vulgar songs, made them look like savages, and produced such disgust and abhorrence in us, that we presently quitted Rovigno and took a walk inland to the distance of about half a stund, between very flourishing olive plantations. When we returned back, we entered a coffee-house, and there had a proof of the poverty and meanness of the inhabitants. We had scarcely seated ourselves at a table upon the grass before the door, and there had coffee brought to us, when we were surrounded by a crowd of children, covered with rags, and displaying a complete example of every corporal want. They solicited us to give them something, by showing off all kinds of tricks; and their impudence went so far as even to steal the fruit from our table. We soon hastened from this wretched city, where we had beheld such a picture of squalid poverty and of the lowest impudence; and, embarking at seven o'clock, we sailed out of the harbour.

"*Hundsberg, near Trieste, April* 20.—We proceeded very slowly on our voyage yesterday evening, on account of the continual calm; and, when we awoke this morning early, we had Citta-nuova in sight. Thence sailing past Usnago, we doubled, at noon, the Punta del Salvora, where we caught a good wind, which, in less than an hour, drove us into the neighbourhood of Trieste. Just then, some tempestuous clouds arose in the horizon; the wind quickly veered about, and became so unfavourable, that we spent as much time in running into the harbour of Trieste, as it had taken us to reach it from the Punta. We had scarcely landed, when the storm discharged itself in heavy rain, and we were thankful to be on terra firma, and in our own room. Every thing is now here in the finest bloom, and the verdant soil promises a rich produce of plants.

"*Hundsberg, April* 22.—It was requisite for us to dry yesterday the plants which we had collected in our journey to Istria, among which *Anemone hortensis*, *Hesperis verna*, *Pistacia Len-*

tiscus, *Laurus nobilis*, and *Phyllyrea media*, had kept remarkably fresh, and afforded a new proof of the indispensable necessity of tin boxes to botanists. We made an excursion to-day to Contobello, and went thither, along the sea-shore, by the new lazaretto. The wind raged violently all last night, and the waves had thrown ashore great quantities of marine plants, among which were some unknown *Fuci*. The mountains which adjoin the beach, are here so steep, that there are but few places where you can climb them; and, for this reason, scarcely any vineyards have been planted on them. *Borago officinalis*, *Polygala vulgaris*, and *Lotus corniculatus* with hoary leaves, were in flower. We passed the road to Contobello, and proceeded, along the sea-shore, to investigate the mountains that border it. Here grew plentifully *Coronilla Emerus*, *Hippocrepis comosa*, *Sherardri arvensis*, and a grass which was very interesting to us, namely, *Schœnus nigricans*. All the plants which we had formerly taken for this species, proved to be only specimens of *S. ferrugineus*. The beauty of the individuals, here determined us to collect them for our publication on grasses, for which we wanted some thirty specimens, all of which must be very carefully prepared; so that we remained on this spot for a couple of hours. The *S. nigricans* grew along the edges of a rivulet that trickled down the mountain. As we went on, we looked up to the verdant hills, and caught sight of a fine red-flowered plant that greatly excited our curiosity; and, as we could not immediately satisfy this, we amused ourselves with conjecturing what it might be. One supposed it might be *Trifolium alpinum*, the other *Pedicularis acaulis*, or *Cytisus purpureus*, but both were wrong; it was an *Astragalus*; and, on account of its beauty, was at once destined for our publication. *Lanica pedestris* was also found under stones; and, as we were busy searching for more specimens of this beetle, a countrywoman, thinking that we were looking for the road, pointed with her hand up the hill, calling out "buona strada." We pursued this accidental hint, and came to a spot which promises much for a future time; and, through a beautiful olive grove, arrived at the road to Contobello. This we crossed; and, after traversing the vineyards, gained the shrubby hills which rise above the station for our *Euphorbia Characias*. Here were some interesting plants, *Thlaspi præcox*,

and *saxatile* in full bloom, and an *Orobus*, which was beginning to unfold its blossoms. At last, on the highest hill, appeared what we thought the glory of all, *Mercurialis ovata*, which is figured and described in the Memoirs of the Botanical Society of Ratisbon. But, as our boxes were now filled, we were obliged to abandon these rare plants for the present, and content ourselves with what we had already gotten.

(To be continued.)

ART. XXVI.—*Observations on the arguments adduced in support of Circular Sterns.*

MR KNOWLES informs us *, that "the advantages derived from the circular sterns, may be classed under the following heads:

"1*st*, A considerable addition to the strength of the ships.

"2*d*, Safety to the people employed in them, both from the effects of a sea striking their sterns, and from shot fired by the enemy.

"3*d*, The additional means afforded for *attack* or defence.

"4*th*, The improvement in the sailing qualities of the ships, by the removal of the quarter galleries."

The first of these advantages will we believe be readily acknowledged. Under the second head we are told that, "in sterns formed according to the old plan, the men on all the decks, excepting those in the lower gun-decks in ships of the Line, are exposed to the most destructive raking fire, their sterns being pervious even to a musket-ball." From this we might be led to conclude that ships' sides would be impervious at least to grape. But the quarter-deck bulwark of a frigate to which I did belong, (and which, during the war with America, was sent on that coast to cope with their large frigates), was "*pervious even to a musket-ball.*"

We are informed, that "the guns can be run out in that part, pointed, elevated, or depressed, with as much facility, and in the same manner, that those are in the sides of ships." But we

---

* *London Journal of Science*, No. xxviii. Art. vii.

are not told; that as all the guns will recoil to a common centre, there will be little room for them to be worked, and that the men being so crowded together, "will be exposed to the most destructive raking fire." We are told, that "when an enemy's ship has laid upon the quarters of any vessel, it has technically been called" "the point of impunity." This is granted; and from the superiority of our tactics, &c., it is the position that we used generally to be able to take; but with the round stern, the fire of at least the aftermost gun on the broadside, when in that position, is entirely lost.

Our author goes on to say, that "Sir Robert Seppings has stated, in his letter before alluded to, that, according to the present disposition of the ports, a three-decked ship can bring at least ten guns to bear upon her assailant, a two-decker eight, and a frigate four." This can be no argument in favour of the curvilinear form, for it is the same number that ships with the old form could fire right aft.

"Their sea-going properties are improved, by the omission of quarter-galleries, which acted as a back-sail, when ships were going on a wind." This must be acknowledged; but what proportion do quarter-galleries bear to poops, which are now put on even to brigs?

That Sir Robert Seppings himself does not think the form perfect, may be proved by his having already twice altered the plan of the Vengeance, which is now building at Pembroke. Is it not a pity, that such extensive alterations should be carried on, before the inventor's own ideas are matured upon the subject?

Mr Harvey mentions *, that "Sir Robert Seppings, in his first appendix to his able letter, has furnished above 120 examples of ships of different classes, the sterns of which have been made the subject of frequent and strong complaint by their respective commanders. To increase the importance of the documents, it is worthy of observation, that they have not been collected from any very limited portion of time, or when any particular feeling in favour of a change of form might have existed in the Navy; but during a period of nearly a quarter of a century." This says nothing more than that Sir Robert Seppings has

* *Edinburgh Philosophical Journal*, No. xiii. Art. 3.

ransacked the records of twenty-five years for examples. And although he tells us, that during this space of time he has been enabled to find 120, still he does not tell us how many instances, in the same space of time, he might have collected, of ships being weak in the bows or elsewhere. And although 120 be in nearly the proportion of five a-year, still what is that in comparison to the number of vessels that were employed "through the trying services of a long and active war?"

Sir Robert, at p. 6. of his letter, very properly remarks, "that circular sterns are formed, and in all respects timbered, and secured, in the same manner as the bow; and consequently equally well adapted to stand the shock of the sea." But though the strength may be equal, the form of the counters is by no means the same as the form of the bows near the surface of the water, which, in resisting the shock of the sea, is of equally great importance. But the upper part of the stern need not be so strong, for we seldom hear of the dead-lights of a frigate or line-of-battle ship being stove in. And in the instances brought forward in Mr Harvey's paper, the weakness is almost invariably occasioned by a tendency in the sides to separate. This being the case, I should think that the stern timbers above the counter, might be considerably smaller than those of the sides and bow. So great a weight being removed from the overhanging part of the counters, would make them comparatively stronger. The great danger to be apprehended from the effects of a sea striking vessels, is either when they broach-to, or are brought by the lee; in both these cases the sea would strike them on the sides. In getting stern-way, the great danger to be apprehended is the loss of the rudder.

"The next point of view in which this important subject may be contemplated, is the consideration of the means which each form of stern affords for *attack* and defence." A comparison is here drawn between Men-of-war and Field-fortification. I cannot say I think this comparison holds good. But if it does, is it not a maxim in fortification, that no gun has its full effect, unless the parapet be at right angles with the object assailed? This, then, being the case, it can seldom happen that more than one gun on each deck, in the aft-part of the vessel, can have its full effect; and every body on board men-of-war knows the diffi-

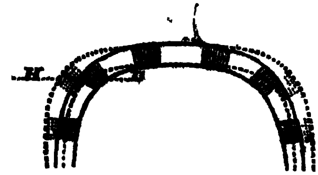
culty of preventing men from wooding their guns in training them. "In the retreat of Admiral Cornwallis before the French fleet, they had no means but of firing right aft." In this case, of course, the after-guns of the broadside were put out of the stern-post; and with the round stern more could not have been done; for had the guns been brought from forward, the trim of the vessels would have been spoilt, and capture would have been the inevitable consequence. "Sir Robert" observes, "they were mutilated to such a degree, to enable them to apply their guns, that a refit of no small extent was necessary." This, I fear, would partially take place now; as of course the iron railings of the stern-walks must be removed; and there is a probability of fire lodging there, as well as the great danger of the ship's catching fire, if the gun that is intended to go through the quarter-gallery port, were not run out to its full extent, which, in the heat of action, is very liable to be the case.

"In the event of future wars," observes Sir Robert, "an alteration in the form of the stern of ships of war, would in all probability be absolutely necessary, by which the guns may be worked with greater effect and facility, in consequence of the introduction of steam-vessels; and that America is firmly convinced that a system of attack, by this description of vessels, is not only practicable, but that it will also be destructive in its operations, is not to be doubted. Indeed," continues Sir Robert, "I have been told, from good authority, that they have lately well manned one of their frigates, given the command of her to a good officer, and directed an experiment to be tried, if a vessel propelled by steam could not, under any circumstances, lay on the quarter of the ship she attacked, and the result was completely in favour of the steam-vessel. If we enquire into the cause of this failure, we shall undoubtedly find, that the frigate was incapable of defending her quarter, owing to the square form of her stern,—a circumstance which could not have taken place, had she possessed one of a circular form." This appears weighty, but I fear it is not so; for if the steam-vessel could, under any circumstances, lay on the quarter of the ship she attacked, she could, with equal ease, take up a position on the bow; and no sooner would her enemies' guns be transported from forward to aft, than she would take up a fresh position. If it

be answered, that there are to be guns in all these parts, (which I believe is not to be the case), the weight of the extreme will be so great, that I fear even Sir Robert Seppings' system of building will not be strong enough to withstand it. A vessel's sailing would be materially injured; she would be laboursome in the sea; and, as I before stated, the stern would be so crowded, that there would be an impossibility of working the guns. I remember trying, on board one of the round sterned frigates (whose name I forget) at Woolwich, what scope the guns would embrace; and so far from being able to take so great a range as is represented by the dotted lines in Mr Harvey's diagram, it would be difficult for the after-gun on the broad-side to fight directly abeam; and I am perfectly convinced that it would be impossible to fire a gun through the quarter-gallery port, in the direction of *D H* in the following diagram. It may be observed, in inspecting the diagrams intended to illustrate Mr Harvey's arguments, that, in the representation of the square stern, the space is left that would be necessary for the size of the gun, and to prevent its being wooded. But some of the dotted lines in fig. 1. actually touch the bulwark. I should hardly conceive this to be a fair representation; nay, it almost looks like prejudice; of which both Mr Harvey and Mr Knowles complain in all those who are opposed to this system; yet is it not more likely that there should be many, (in a country already grateful for the many benefits Sir Robert Seppings has conferred on it), equally prejudiced in favour of this method; and it must be remembered, that though many look with caution on innovations, there are still many others equally eager for novelties and fancied improvements.

The opinion of Mr Dupin is quoted by Mr Harvey. "Act contrary," says this enlightened author, "to what has hitherto been the practice; and if possible make the means of defence of that part most exposed ten times as great as it now is." This argument has not equal weight with us, as the stern of a British man-of-war, is not the part most exposed.

Thus I am led to conclude, that the method of building is very good; but still that the stern should be as nearly square as this method of building will allow.



In the annexed sketch, the black lines represent the form as given by Mr Harvey, and the dotted lines the alterations which I venture to propose. It will here be seen that the after-gun on the broadside has its full effect. The gun at the salient has fully as great a range as the quarter-gallery gun on the round stern; and there will be more room for the men to fight their guns.

Art. XXVII.—*On the Discovery of the Foramen centrale of the Retina in the Eyes of Reptiles.* By Dr Knox.

All anatomists are aware, that, previous to the discovery of the *foramen centrale* in the human retina, by Dr Sœmmering, this important structure had completely eluded observation. Since that time, the most active researches have been made into the structure of the eye-ball, in every class of animals; but the only additional fact which has, in consequence, been added to the discovery of Sœmmering, has been, that the *foramen centrale* is not confined to man, but extended to several of the quadrumanous animals; and, more particularly, to the real apes of the Old and New Continent. The more obvious conclusion, drawn from these facts, and which, perhaps, was warranted by the state of knowledge at the time, was, that the *foramen centrale*, the accompanying fold of the retina, and the yellow spot, were simply proofs of a high degree of organization in man, and that their reproduction in apes, was owing to the general resemblance these animals bore to the human species. But the very singular and unexpected discovery which has some time ago been communicated to us by Dr Knox, entirely refutes these suppositions, and will compel physiologists to look for other explanations, and may ultimately change several prevailing notions relative to the theory of vision.

The full details of this discovery, are intended for the Transactions of the Wernerian Society of Edinburgh. In the mean time, we may state, that the reptiles in whose eyes the *foramen centrale*, and fold of the retina, have been observed, belong to the class Lizards; such as the *Lacerta scutata*, *superciliosa*, *Calotes*,

&c. but that it is wanting in the *Mabuya*, *Gecko*, &c. The appearances are much more developed, comparatively, than in man; so that they can be examined with the greatest ease.

The following letter, containing additional information on the subject, has been received from Dr Knox :—

"Dear Sir, *4th August* 1823.

I think I mentioned to you, some time ago, when I had the honour of communicating to you my discovery of the *foramen centrale* of the retina in reptiles, that I expected to find the same appearances in the Chameleon, whose eye I had not then examined. The specimen you were so kind as send me lately, has verified these conjectures; for I find, in the eye of the chameleon, the *foramen centrale* to be remarkably large and distinct, exceeding greatly, proportionally, and even in absolute size, the same parts in man. The fold of the retina, extending from the *foramen centrale* to the entrance of the optic nerve, is equally apparent: there is even an appearance of a continuous fissure connecting these parts together; but this appearance I ascertained to be deceptive.

"It is not my intention, at present, to enter into any details relative to this very remarkable structure in the eyes of reptiles, nor to offer any hypothesis relative to its cause; yet I do not hesitate to affirm it as my belief, that, ultimately, much light will be thrown, by this discovery, on the subject of vision in man, and other animals, and perhaps on the nature of light itself.

"I am, at the present moment, engaged in prosecuting the inquiry, and shall have the honour of submitting to you the results, as soon as completed. I am, &c. R. Knox.

"To Professor Jameson."

Art. XXVIII.—*Observations on the Difference of the Shell of Individuals of Different Sexes in the Cephalated Mollusca.* By M. de Blainville.

On perusing with some attention the numerous works of modern geologists upon the distinction of fossil organic bodies, and especially upon that of the species of univalve shells, which have belonged to the class of cephalated Mollusca, the zoologist is

really astonished at the facility with which certain geological conchologists have multiplied the number of genera, and especially of species, without its, perhaps, being ever inquired, what is a genus, or a species of shells, and upon what characters can the distinction be established. The greater number seem to leave themselves, as it were, to the direction of a sort of instinct, scarcely studying even the aspect or habit; and yet the consequences which they elicit from these preparatory works, if we may so call them, are often of great importance in geology; since, from the identity, more or less complete, of the fossils of two strata, often situated at considerable distances, they infer the identity or difference of those strata, their order of superposition, and their relative antiquity. I shall not at present stop to show how, in general, the employment of fossils in geology is liable to abuse, although it cannot be denied to be of the greatest utility, when properly managed; and how it would be of importance, before deciding whether a species of shell is lost, or differs from another found at more or less considerable distances, to be somewhat better acquainted with the species which live in our seas at the present day; and the differences which age and local circumstances produce in the same species, and which are much greater than is generally thought. My object is merely to make known, in this notice, an observation which I made a considerable time ago, upon the difference of individuals of different sexes, in certain species of shells of the class of cephalated Mollusca.

Although little attention has been paid to the subject until of late years, we now know that this class of mollusca contains three very different combinations of the generative apparatus. In the first, the sexes are separated in two different individuals. The whole of the species of this section are not operculated, but the operculum only occurs in this group. In the second combination, the two sexes, although really distinct, are united in the same individual; and, lastly, in the third, we can only distinguish one sex. It is according to this consideration of the generative apparatus, that I propose henceforth to divide the first class of molluscous animals into Diœcious, Hermaphrodite and Monœcious Cephalata; a subdivision which does not seem to me to destroy any natural relation, and which perfectly corresponds with the animal degradation, by establishing a passage to-

ward the class of acephalous mollusca. In these last, as in the second and third section of cephalated mollusca, the shell or protective envelope, simple or complex, presents only individual differences determined by age or by some accidental circumstance; but, in the first, the case is different; and I am already assured, that, in several genera, whose animals I have seen, the shell of female individuals is always more bulging, especially in the last revolution, which renders the orifice more widened to the right, and that the spire is less attenuated and less pointed than in the male individuals. This is particularly well marked in the Buccina, Cyclostomata, Paludinæ, and in the Ampullariæ, which, it is true, differ so little from this last genus, that I am assured from dissection, that it would be difficult to separate them generally from it. Hence, it would appear, that, in future, conchologists would do well to attend, when distinguishing species of shells, to the differences which I have here pointed out *.

ART. XXIX.—*Reply to Mr Brooke's Observations on the connexion between the Optical Structure of Minerals and their Primitive Forms.* By DAVID BREWSTER, LL. D. F. R. S. Lond. & Sec. R. S. Edin.

IN the year 1817, I had occasion to announce to the Royal Society of London the existence of a physical law, by which the *Primitive Forms of crystallized bodies could be inferred from the number of their axes of double refraction* †. This law was established by a comparison of my own observations on the polarising structure of crystals with Haüy's Table of Primitive Forms; but as one of Haüy's divisions contained a greater number of erroneous than of correct determinations, I was of course obliged to state as exceptions to the law what were really examples of it, and to give as examples of it what actually constituted exceptions.

In a Memoir, printed in the *Wernerian Transactions*, vol. iii. p. 50., I pursued this subject to a greater length; and in a subsequent Memoir, vol. iii. p. 337., laid before the same scientific body, I exhibited the law in its most general form, and freely

---

* *Journal de Physique*, 1822. † *Phil. Trans.* 1818.

stated all the exceptions to it which were then known. These exceptions were as follows:

Sulphate of Magnesia.	Cryolite.
Chromate of Lead.	Harmotome.
Mesotype.	Chabasie.
Carbonate of Barytes.	10 Sulphate of Iron.
5 ——— Strontites.	Essonite.
Iolite.	

These *Eleven* exceptions to a law otherwise general and comprehensive, were ascribed by myself and others to the circumstance of the primitive forms of the minerals having been erroneously determined; and as I was then aware, from actual experiment, that the optical structure of a crystal was dependent on the mechanical condition of its parts, I did not scruple to predict, and to publish the prediction, *that all these* eleven *exceptions had their foundation in crystallographic errors*, and that these minerals would be found to possess primitive forms, in perfect conformity with the general optical law which I had discovered.

Crystallography and Optics were thus fairly placed at issue, and there was no method of evading the decision of the mineralogists of Europe. If these *Eleven* bodies were found to possess the primitive forms assigned to them by Haüy, either the optical law which I promulgated must have instantly fallen to the ground as an imposing though imperfect generalisation, or the crystallographic method must have enjoyed the proudest triumph.

The result, however, of this trial of strength was very different indeed. *All the minerals out of the* eleven *which have been carefully re-examined by mineralogists, have been found to have different primitive forms from those assigned to them by Haüy, and in all of them has my prediction been accomplished.* These minerals are,

Sulphate of Magnesia.	Carbonate of Strontites.
Chromate of Lead.	Harmotome.
Mesotype.	Sulphate of Iron.
Carbonate of Barytes.	Essonite.

The remaining three, viz. *Iolite*, *Cryolite*, and *Chabasie*, have not been re-examined. Mr Brooke, however, considers that *Cryolite* may have a different primitive form. I have deter-

mined, that the biaxal *Chabasie* is a new mineral different from the ordinary Chabasie; and therefore, *Iolite* is now the only exception to the law, or rather it is no exception at all, as its crystallographic structure was never determined with care *. In a short time it must follow the fate of the rest, and will be handed over with the other *ten* exceptions to the dominion of the optical system.

I would now venture to ask the candid inquirer after truth, if he is acquainted with any law in Chemistry or Physics which is supported by a sounder or a more extensive induction, than that optical law which connects the primitive forms of minerals with the number of their axes of double refraction? It stands pre-eminent among crystallographic generalisations, without a single ascertained exception;—it has corrected the deductions of the most distinguished crystallographers of Europe;—it has enabled those who confide in its accuracy, to predict the results of crystallographic researches;—and, what has not been sufficiently attended to, it is a law founded on experimental evidence, that the optical phenomena are the *necessary results of a mechanical structure*, and that their indications must infallibly harmonize with the sound deductions of crystallography.

Under such circumstances, I experienced no inconsiderable surprise at finding in Mr Brooke's *Familiar Introduction to Crystallography*, what every person who understands the subject must regard as a groundless animadversion upon the Optical System of Mineralogy. In discussing those well-known and now numerous examples where chemistry and crystallography are at direct variance, as mineralogical methods, Mr Brooke has treated the great host of chemical analysts with the deference which they so well merit; and has very properly allowed "that all such anomalies will probably be reconciled by the future investigations of science." He has declined, however, to extend to the optical system the same courtesy, and has opened all the trenches of chemistry and crystallography against a new and incomplete fortress, reared and defended by a single man at arms. The reader is not even told what the system is which is assailed; he is not made aware that it has

* I understand that Professor Mohs has made *Iolite* Brismatic, solely on the authority of Haüy.

any foundation at all as a general principle; he is not told of its successive triumphs over every positive objection that has been urged against it; but he is hurried at once, and without ceremony, to witness its demolition.

Unwilling to occupy my time with such discussions, and believing that Mr Brooke's observations would pass unnoticed by the great body of his readers, I had resolved to content myself with a private reply; but I observe, in the last Number of the *Annals of Philosophy*, that its learned editor has quoted the whole of Mr Brooke's animadversions as something *important to science*, and has thus given additional currency to the only part of his book which is not characterised by that sagacity and discrimination which mark all the writings and labours of its respectable author. I feel myself, therefore, called upon to analyse the objections of Mr Brooke; and, in order that I may not misrepresent his reasoning, I shall print every syllable that he has written upon the subject under discussion.

"Dr Brewster (says he) has, with that attachment which we usually evince towards a favourite pursuit, given a preference to the optical characters of minerals, as the surest means of determining their species. See a memoir by Dr Brewster in the *Edin. Phil. Journ.* vol. vii. p. 12.

"This memoir relates to a difference in the optical characters of the apophyllites from different localities, upon which Dr Brewster proposes to erect a particular variety into a new species, under the name of Tesselite. Berzelius, as it appears from a paper preceding that of Dr Brewster, in the same volume of the Journal, has, at Dr Brewster's desire, analysed the Tesselite, and found it agreeing perfectly, in its chemical composition, with the apophyllites from other places. *Chemically, therefore, the Tesselite does not appear a distinct species.*"

The conclusion, as now stated by Mr Brooke, I must positively deny. It will be seen from a note, presently to be quoted from Mr Brooke's work, that he is not acquainted with the optical structure of Tesselite, and that if he has seen it, he has neither studied nor understood it. Tesselite is a crystal possessing the most extraordinary structure,—a structure which defies all the laws of crystallography. It is a substance beautifully organised by material laws, of which we cannot even form a conjecture. It is a substance built up, as it were, of the most singular elementary parts, *all of which parts have different optical and mechanical properties.* Hence an analysis of Tesse-

lite resembles the analysis of a bird, the feathers, flesh and bones of which are all pounded together in a mortar, and submitted in a mass to the action of destructive agents. Mr Herschel, whose opinion on this subject must have great weight, observes, when speaking of Apophyllite, "The specimen I am now de-"scribing presents the hitherto unique *combination of no less* "*than three distinct substances*, uniting to form a single crys-"tal." "It would certainly be *in the highest degree interest-"ing to subject them all three to chemical analysis*; but as the "total weight of the specimen presenting these anomalies did "not exceed 60 grains, of which nearly one-half consisted of "the ordinary variety, I have not sufficient confidence in my "own chemical dexterity to enter on so very delicate an in-"quiry, which would obviously call for a degree of precision at-"tainable only by consummate masters in the art of mine-"ral analysis." "*It remains, therefore, to be ascertained*, "whether their different actions on light be owing to a differ-"ence in composition, or merely in their state of aggregation." *Cambridge Transactions*, vol. i. When M. Berzelius, therefore, or Mr Herschel, who is perfectly capable of executing what he too modestly shrinks from, shall have performed this *interesting analysis*, it will be competent for Mr Brooke to say, that Tesselite either is or is not chemically the same with Apophyllite. If the analysis of each part shall turn out similar to that of the whole, philosophers who know what Tesselite actually is, may perhaps still decide that two bodies may be chemically the same, and yet mineralogically different.

Let us now follow Mr Brooke into his own stronghold of crystallography.

"A few days (he continues) before Dr Brewster's paper was published, it happened that I had been measuring the angles of apophyllites from most of the localities in which they occur, all of which I found to agree with each other more nearly than different minerals of the same species frequently do. *The Tesselite is not, therefore, crystallographically a new species* *. But when chemistry and crystallo-

* *Note by Mr Brooke.*—"I have found several crystals of this substance, corresponding in a remarkable manner in their general form, of flattened four-sided prisms, terminated by four-sided pyramids with truncated summits, *but with their corresponding planes dissimilar*; the planes which appear as the summits of some of the prisms, being only the *lateral planes of very short, and otherwise disproportioned*

graphy concur *so perfectly* as they do in this instance, in determining the species to which a mineral belongs, it will be difficult to admit a *variation of optical character* as a sufficient ground to alter that determination."

This syllogism is full of errors, and all its parts are incorrect. It is assumed,

1. That Tesselite and Apophyllite are chemically the same.
2. That they are crystallographically the same.
3. That Tesselite is only marked by a *variation of optical character*.

The first of these propositions has been already shewn to be an assumption; the second is positively erroneous; and the third is in every point of view incorrect.

When Mr Brooke says that Tesselite and Apophyllite are crystallographically the same, he must mean not only that they have exactly the same angles, but that they have the same cleavages, and the same primary form. Nothing, however, is said about cleavage, but the identity of crystallographic structure is inferred from equality of angles. Mr Brooke will, no doubt, be surprised to learn (what a perusal of my papers on Apophyllite could have informed him of long ago) *that Tesselite possesses cleavage planes, and faces of composition, totally different from those of ordinary Apophyllite, and totally irreconcileable with the crystallographic structure which he assigns to it.* These faces of composition are not inferred from optical phenomena; *they are visible by common light, and with the aid of a simple microscope*,—an instrument which ought to be more frequently in the hands of crystallographers. Mr Brooke has, therefore, not determined, because he has not studied, the crystallographic structure of Tesselite. The note which we have reprinted at the foot of this and the preceding page, affords a demonstration that he has no more idea of the structure of Tesselite than he has of one of the fixed stars. The very phrase, indeed, by which Mr Brooke marks the difference of the two minerals, viz. *a variation of optical*

---

crystals; so that a line passing through these in the direction of their greatest lengths, would in fact be perpendicular to the axis of the primary form. Sections perpendicular to the axes of these apparently similar prisms, would certainly present very different optical phenomena. But it is not probable that the practised eye of Dr Brewster should have been misled by their apparent similarity, and the differences he has observed will still remain to be explained."

character, must convince those who have studied the subject, that he entertains very inadequate conceptions of those singular *optical*, and *physical*, and *crystallographic* differences, which separate the Tesselite from all other substances in nature. What would we say of a traveller, who should maintain that a house built with a variety of kinds of granite, and consisting of apartments beautifully and symmetrically arranged, was the same thing with one of the granite blocks which rest upon the flanks of Jura? In this comparison, we give the traveller the advantage of having the angles as well as the composition of both the masses assumed as identical; but our surprise would be still greater, if he should persist in his opinion, when a chemist should inform him, that not one of the supposed granites which compose the house had ever been separately analysed.

We come now to Mr Brooke's objection to the optical system, as derived from the *Sulphato-tri-carbonate of lead.*

"A paragraph (says he) published by Dr Brewster in the 6th volume of the same Journal, relative to the crystalline form of the *sulphato-tri-carbonate of lead,* furnishes an additional motive to believe that the connection between the optical character of minerals, and their crystalline forms, is not yet sufficiently understood.

"Dr Brewster admits, what I believe is not liable to question, that *the crystals of this substance are acute rhomboids.* But, he adds, "Upon examining their optical structure, I find that they have two axes of double refraction, the principal one of which is coincident with the axis of the rhomb. The sulphato-tri-carbonate, therefore, cannot *have the acute rhomboid* for its primitive form, *but must belong to the Prismatic System of Mohs.*"

"But it appears," adds Mr Brooke, "from the outline of Professor Mohs' new System of Crystallography, published in vol. iii. of the same Journal, that *a rhomboid cannot belong to his Prismatic System.** For, it is stated in p. 173., "that the rhomboid and the four-sided oblique based pyramid (the fundamental form of the Prismatic System), are forms which cannot by any means *be derived from each other; the* (*two*) *groups of simple forms, as well as their combination,* must each be always distinct from the (other) *.

"If, therefore, in the hands of Dr Brewster, the use of optical characters cannot at present be relied upon for the determination of a mineral species, it may be doubted whether they can be successfully employed by less accurate and less intelligent observers."

* Had Mr Brooke read my papers on the subject on which he writes, he would have found (See *Wernerian Transactions,* vol. iii. p. 341.) that I admit all this.

None

In the preceding extract, it is taken for granted, that the primitive form of the *sulphato-tri-carbonate of lead* has been determined crystallographically to be the *acute rhomboid*, and I am said to have admitted this myself. I admit, it is true, that the crystals have *to the eye* the figure of acute rhomboids, precisely in the same manner as the crystals of *Sulphate of Iron* appeared, to the practised eye of the celebrated Haüy to be acute rhomboids; but having found, notwithstanding this appearance, that both the *sulphato-tri-carbonate of lead*, and the *sulphate of iron*, have two axes of double refraction, I conclude, and I persist in the truth of the conclusion, that both the sulphato-tri-carbonate of lead, and the sulphate of iron, have not the acute rhomb for their primitive form, but belong to the prismatic system. Dr Wollaston detected the mistake of the Abbé Haüy, and proved that *sulphate of iron* was a rhomboidal prism, and it is very likely that some other crystallographer *may* detect the mistake of Mr Brooke. But I deny that Mr Brooke has determined the primitive form of the sulphato-tri-carbonate to be an acute rhomboid. In his own original description of this mineral, in the *Edin. Phil. Journal*, vol. iii. p. 119., he says, "The rhomboids are acute, measuring 72° 38′ and 107° 30′; and from not having found any other cleavage than one perpendicular to the axes of the crystal, *I am induced to adopt this as the primary form* *. The natural planes of all except *the most minute crystals*, are more or less rounded, and consequently afford imperfect reflexions."

In Mr Philips's excellent work on Mineralogy, newly published, and enriched with the crystallographical observations of Mr Brooke, it is observed, that "the primary form of the sulphato-tri-carbonate of lead is *considered to be* an acute rhomboid." The whole of Mr Brooke's argument, therefore, is

---

"None of these forms," I remark, "are capable of being derived from one another, and; therefore, each of them, as well as all their combinations, must remain entirely distinct from the rest." His argument, such as it is, would have been greatly strengthened by quoting my own admission, and it would have been advantageous to me, by shewing his readers that I was not ignorant of Professor Mohs' System.

* It appears from this quotation, that one may with accuracy say, that a crystal is an acute rhomb, without maintaining that an acute rhomb is its primitive form.

a mere shadow.—When he has pledged his character as a crystallographer, that the *sulphato-tri-carbonate of lead* has an *acute rhomboid* for its primitive form, it will then be time to consider whether or not such a result is hostile to the optical law.

Let us suppose, however, that this result is obtained, and that all the crystallographers of Europe concur in opinion that the primitive form of that mineral "is a solid, contained within six equal rhombic planes, and having two of its solid angles, and only two, composed each of three equal plane angles." Then, because the mineral which crystallises in the form of this solid has two axes of double refraction, I maintain that its primitive form is the *oblique rhombic prism*, which forms the limiting solid between the two series of oblique rhombic prisms, the side of whose base or summit plane is either less or greater than the sides of any of its other planes. Upon the same principle, I have already maintained, and some of the first crystallographers have agreed with me in opinion, that *Boracite* * is not a *Cube* but a *Rhomboid of* 90°.

Here, then, lies the beauty, and the power of the optical system. It not only determines the class of primitive forms, but it determines, what crystallography is incapable of doing, those limiting solids which form the nodes of every series of geometrical bodies. If we take a crystal, for example, bounded by six equal square faces, the crystallographer will content himself with calling it a *cube*; but the optical mineralogist will only call it a *cube* when it has *no double refraction*. He will maintain it to be a *rhomb*, if it has *a single axis of double refraction, coincident with one of its diagonals*; and he will consider it as a *right prism with a square base*, if it has *a single axis of double refraction, perpendicular to any two of its faces*. The position of the axis of double refraction shews, that the mechanical condition of the parts of the crystal are related to that line in which it is invariably found in every rhomboid, and in every prism with a square base.

I may now be permitted to add, that while the optical system in this respect leaves the ordinary resources of crystallography far behind it; it also enjoys the peculiar property of determining all *structures of composition* to which the crystallographer

* See *Edin. Phil. Journal*, Vol. V. p. 217.

must ever remain blind. These composite minerals, often resembling homogeneous minerals in their external form, are now so numerous, that it has become necessary to establish a *new system of crystallisation* for the purpose of receiving them, not merely because they are entirely different bodies from homogeneous crystals, but because they are formed by new laws and new principles of combination, which philosophers have yet to develope. Crystallography will then be divided into *Five* Systems:

1. The Rhomboidal System.
2. The Pyramidal Sytem.
3. The Prismatic System.
4. The Tessular System; and,
5. *The Composite System.*

Having thus removed every objection that has been urged, either against the accuracy or generality of the optical method, I shall now briefly contrast it with the crystallographic method, in reference to their power of discovering new minerals. It would require the limits of a volume to explain the various characters of mineral bodies which the optical method supplies. They are of the most palpable and definite kind;—and connected as they are with some of the most curious researches of modern science, they elevate Mineralogy from a descriptive branch of Natural History to a lofty station among the Physical Sciences. I might here adduce numerous instances where these characters have led to the immediate discovery of new minerals, when crystallography supplied no discriminating tests; but I shall confine myself to two cases, which have a special application in the present discussion. The minerals of the Zeolite family having been particularly examined by Mr Brooke and by myself, we have had occasion to apply our respective methods of observation to several minerals which had not been carefully studied by preceding mineralogists. Two of these minerals were the *Nadelstein of Faro*, and a mineral from Aix-la-Chapelle, supposed by Haüy to be a *Stilbite* *. All the resources of crystallography

* A description of this mineral, to which I have given the name of *Hopeite*, was read before the Royal Society of Edinburgh on the 17th June, and will appear in the next volume of their Transactions. The *Nadelstein* from Faro is a mos-

in the hands of Mr Brooke, were unable to distinguish these minerals from those already known, and even M. Haüy failed in his examination of the last of them; but by the application of the optical method, I have determined both of them to be new minerals, and the accuracy of these determinations has been completely established by chemical examination.

Another argument in favour of the optical system may be derived from the recent determination of the primitive forms of nineteen artificial crystals, which we owe to Mr Brooke. The primitive forms of *fifteen* of these I had previously predicted by the optical method, as shewn in the following list:

Rhomboidal.	*Pyramidal.*
Nitrate of Soda.	Arseniate of Potash.

Prismatic.

Rochelle Salt.	Bicarbonate of Potash.
Acetate of Soda.	Tartaric Acid.
Acetate of Zinc.	Oxalic Acid.
Binacetate of Copper	Citric Acid.
Sulphate of Magnesia *.	Sulphate of Iron.
Tartrate of Potash, and Antimony.	Sulphate of Cobalt.
	Chromate of Potash.

All these results are in perfect conformity with the more recent determinations of Mr Brooke and M. Levy. The last of these crystallographers has ranked the *Prussiate of Potash* under the Pyramidal System; while the optical method places it in the Prismatic System. M. Levy will, we have no doubt, see reason to correct this determination.

I shall now conclude these remarks, already too much extended, by a single observation. If all that I have now said is erroneous, —if *Tesselite* and *Apophyllite* are the same body;—and if the *Sulphato-tri-carbonate of lead* is an exception to the optical

singular substance, both in its structure and properties, and yet the most eminent of our crystallographers has not been able to distinguish it from the *Iceland Mesotype*.

* By this result Mr Brooke has given a striking confirmation of the optical method. Haüy made the *Sulphate of Magnesia pyramidal*; the optical method made it *prismatic*, and both Professor Mohs and Mr Brooke have confirmed this last result.

system; then I would supplicate Mr Brooke to extend to that system the same indulgence which he has shewn to chemistry; and that he would, in his next edition, conclude his observations on it with the same words with which he has concluded his observations on chemical analysis: "These anomalies will, however, probably be reconciled by the future investigations of science."

EDINBURGH, Aug. 9. 1823.

ART. XXX.—*General View of the Geognostical Structure of the Country extending from Hudson's Bay to the Shores of the Polar Sea.* By JOHN RICHARDSON, M. D., Member of the Wernerian Natural History Society, &c.

WE have great pleasure in laying before our readers this luminous sketch of Dr Richardson's, extracted from one of the most deeply interesting and affecting narratives ever laid before the public, the Journey to the Shores of the Polar Sea, by Captain William Franklin.

"The observations of Werner, Humboldt, Von Buch, Saussure, Ebel, and Daubuisson, in many districts on the Continent of Europe, and in America, and by Jameson in Scotland, shew that the general direction of the primitive and transition strata is nearly from NE. to SW. It is therefore interesting to find, that the general result of my notes on the positions of these rocks, which we traced (except in a few instances, when our route lay to the westward of their boundary,) through 12 degrees of latitude, also gives NE. and SW. as the average direction of their strata.

The strata of the two classes of rocks just mentioned, were always more or less inclined to the horizon, the mean angle considerably exceeding 45°. Their dip was sometimes to the east, sometimes to the west.

These rocks exhibited the same varieties of structure that they do in other extensive tracts of country. In general, the slaty structure was parallel to the direction of the strata, as in gneiss, mica-slate, clay-slate, &c. When the waved structure

made its appearance, it was sometimes conformable with the seams of stratification, as was very often noticed in the transition clay-slate of the Copper-Mine River; or it was entirely independent of these, and then it was very irregular in its direction. The *apparently confused* arrangements of structure of clay-slate and other slaty rocks, more particularly observed at the Magnetic Islet in Knee Lake, and on Point Lake, proved, on a more extended and accurate examination, to be caused by the arrangement of the mass of strata into variously formed distinct concretions, in many of which the direction of the slaty structure was under very different angles, and in very different directions. In short, in these apparently disturbed strata we had, though on a great scale, the same beautiful arrangement that occurs in the rock named by Werner "Topaz-Rock." Independent of these various structures observable in individual strata, we remarked that the strata themselves, whatever their structure might be, were either variously waved or quite straight in their direction.

The general forms, connections, and distributions of the mountains, hills, and plains, in the tracts we traversed, and of the cliffs on the coast of the Arctic Sea, were nearly the same that geologists have remarked as characterising similar rocks, similarly circumstanced in other quarters of the globe.

Granite with sienite, gneiss, mica-slate, and clay-slate, which some geologists consider to be the predominating primitive rocks, occur in all their usual relations. Of these the gneiss appears to be the most extensively distributed, and to be always attended with a very scanty vegetation. Granite is the next in frequency, then mica slate, and the least abundant are the clay-slate and protogene. The granite is generally of a red colour, and varies from coarse to small granular. The loose blocks of stone, which crown the summits of almost all the hills in the *barren grounds*, are generally of this latter variety. Of the gneiss there are two varieties, the one red and the other grey. The mica-slate, clay-slate, and sienite, present the common varieties. The protogene granite, of which there is considerable abundance in Leave River, and in some other quarters, appears to belong to the mica-slate formation.

These primitive rocks are traversed by veins of felspar, quartz, and granite; and the granite of Cape Barrow was also intersected by veins of augite-greenstone of the same description with those met with in the granite districts of Great Britain. The occurrence of the vein of galena at Galena Point, is an interesting fact, as connected with the geographical distribution of that important ore. The Esquimaux that frequent the shores of the Arctic Sea, make their culinary utensils of potstone; but we did not discover the place from whence they obtained it.

The transition rocks were observed *in situ* only at Point Lake, on the Copper-Mine River, and, perhaps, at Wilberforce Falls on Hood's River, and, as far as our observations extended, afforded neither limestone nor lydian-stone. None of the transition-slate that we examined, contained chiastolite; and if any beds or imbedded masses of glance-coal existed, they escaped our notice. The transition rocks being principally clay-slate and grey-wacke, bore a strong resemblance to those in Dumfriesshire, my native country.

The secondary formations, if examined by travellers more fortunately situated than we were, will doubtless exhibit many curious and highly important relations. The facts already stated, shew that the following formations of this class occurred on or near the line of our journey.

1st, The *old red sandstone*, or that which lies under coal, and occasionally alternates with transition rocks. This was observed upon the Copper-Mine River.

2d, The *coal formation*, which did not present itself in the direct line of our route; but as it is known to occur in some districts in Mackenzie's River, and also towards the Rocky Mountains, placed apparently upon the old red sandstone, and under the vast deposit of secondary limestone, it is here mentioned.

3d, The *new red* or *variegated sandstone*. This important formation is of very considerable extent in several of the tracts we passed through, and probably lies over an extensive deposit of the coal formation. In some instances, where the old red sandstone was wanting, it appeared to us as resting upon gneiss and other primitive rocks. Here, as in other quarters of the world, the new red sandstone contains gypsum and salt-springs that seem to issue from it, implying that it contains beds of

salt or muriatiferous clay, which afford the impregnating materials to the springs. The springs on the Leave River afford, by spontaneous evaporation during the short summers, a very large quantity of fine salt.

4th, The secondary limestone appears generally to belong to the vast deposit which lies above the new red sandstone and under chalk, and which is known to form very extensive tracts of country, not only in other quarters of North America, but also on the Continent of Europe and in England. Some of the varieties may, on more minute examination, prove to belong to the mountain limestone of geologists.

5th, The secondary trap and porphyry rocks, which occur so abundantly on the coast of the Arctic Sea, and throughout the whole extent of the Copper Mountains, are, to all appearance, connected with the new red sandstone. The frequency of native copper in those rocks, both on the Copper Mountains and on the sea coast, is a very interesting feature in their composition, and deserves the particular consideration of those who make the grouping or associations of simple minerals objects of attention. Many of these trap and porphyry rocks presented the columnar structure which has been considered as indicative of a volcanic origin, but their other characters, and the horizontal strata upon which they reposed, seemed to give them a still greater claim to Neptunian origin. Our opportunities of observation, however, were much too limited to permit us to offer a decided opinion upon this disputed point.

Alluvial Deposites.—The extensive formation of these deposites in the line of our journey, afforded us numerous examples of their different kinds. In the preceding notes, we have alluded to extensive alluvial formations, occasioned by lakes which have either gradually dried up, or have burst suddenly, and left their concavities more or less deeply covered with sand, gravel, and other alluvial matters. Other kinds have evidently had their origin from the action of rivers. Some formations on the sea-coast were occasioned by the conjoined action of the sea, and the wasting influence of the weather. The peninsula between Point Turn-again and Melville Sound, is almost entirely composed of a low flat of this kind, a few trap-cliffs appearing at considerable distances only. The general wasting influence

of the weather on the more elevated exposed rocks throughout the country, has formed a covering of alluvial matter of greater or less depth to the subjacent rocks, which protects them from the further gnawing effects of the atmosphere.

With regard to the large rolled blocks which are so plentifully scattered over the surface of some countries, and which have been considered to have been deposited by the waters of the flood, we have no remarks of moment to make. During our journey from York Factory to Fort Enterprise, we seldom had an opportunity of ascending out of the valley of the river through which our route lay, and any blocks of stone observed in such a situation, may as readily be supposed to have been transported by the river as by a more general cause. On the barren grounds, where we adopted a different style of travelling, the loose stones, which were very numerous, even in the most elevated situations, were, as far as we observed, similar to the rocks on which they rested, and may be supposed to be the more durable remains of the covering strata, which have been destroyed by long-continued action of the atmosphere. Their angular forms, and their resting places, often upon the very summit of the hills, militate against their having travelled from a distance.

The very general, though rude, resemblance these rocks bore to large crystals, is a remarkable circumstance, and seems to indicate a crystallization in the great of the red granite, of which they were very frequently composed, and of whose beds or strata they are perhaps the remains.

We may conclude with observing, that the preceding details show, that, in the regions we traversed, the rocks of the primitive, transition, secondary, and alluvial classes, have the same general composition, structure, position, and distribution, as in other parts of America which have been examined; and as these agree in all respects with the rock formations in Europe and Asia, they may with propriety be considered as universal formations, parts of a grand and harmonious whole, the production of infinite wisdom."

Art. XXXI.—*On the Anatomy of the Ornithorynchus Paradoxus of New South Wales.* By Dr Knox.

Several months have elapsed, since Four Memoirs of considerable extent, on the anatomy of this extraordinary animal, were deposited with the Secretary of the Wernerian Society, with drawings, illustrating the discoveries of the Poison-gland and Spur, the disposition of the abdominal viscera, organs of generation, &c. These memoirs the Society has it in contemplation to publish in the next volume of their Transactions. In the mean time, we have thought it might be interesting to some of our readers, to present them with a brief abstract, which should give a condensed view of the whole of the discoveries, some of which are at least as important as any that have been made for a long time, in the department of comparative anatomy. We may mention, that the specimen of the Ornithorynchus was sent to the Museum of the University, by his Excellency Sir Thomas Brisbane, Governor-General of New South Wales; and was entrusted for the purpose of dissection, by Professor Jameson, to Dr Knox. Most of the organs have been preserved, and the skeleton of the animal has been deposited in the Museum.

The First Memoir treats of "the organs of Sense, and of the anatomy of the Poison-gland and Spur" of the animal; read before the Wernerian Society on the 17th May 1823.

In the commencement of this memoir, the author observes, that numerous dissections of the Ornithoryhchus paradoxus had been made in England, France, and Germany, by distinguished comparative anatomists, and more particularly by the author of the immortal "Leçons d'Anatomie Comparée," by Professors Blumenbach, Blainville, Rudolphi, and others. He observes, that the greater part of the details found in the writings of these gentlemen, relative to the anatomy of the internal parts, of the teeth, of the muscles of deglutition, &c., are extremely correct, and admit not of the least question; but that some parts of the animal, such, for example, as the bones, had been treated superficially; others, as the nervous system, had apparently been altogether neglected; whilst certain organs, or assemblage of organs, as the poison-gland and spur, had been completely misunderstood, and that the most extraordinary er-

rors prevailed regarding them. Dr Knox attributes these errors to the mutilated state in which, probably, the specimens examined by these celebrated anatomists were in at the moment of dissection. The author describes the organs of sense, as far as they could be seen without mutilating the skeleton, which it was necessary to respect. The integuments are strong and compact. The hair with which the animal is closely covered, is of two sorts; one fine and silky, the other strong, spear-shaped, and resembling bristles rather than hairs. These are found chiefly on the beaver-like tail of the animal, and establish a certain relation between the Ornithorynchus and Echidna, an animal closely allied to it in other respects. The strength and general development of the *panniculus carnosus* still farther confirm this opinion. The bill, that remarkable feature in the ornithorynchus, is considered as the organ of touch, by means of which the animal searches for its food. The supply of nerves to it from the fifth cerebral pairs is quite prodigious, though the author renders it probable that it is not the gustatory organ. The lateral reduplications of the membrane of the bill, do not increase the sentient surface so greatly as might be supposed.

The memoir is particularly full on those parts of the organ of hearing which came under observation. It would seem that the animal is not altogether without external ears, as has been stated by preceding anatomists; but that the cartilaginous expansion of the external tube of the ear, and which constitutes a real *concha*, is found immediately under the integuments, and so loosely attached to them, as to be capable of considerable motions, by means of muscles transmitted to it from the *panniculus carnosus*. The tympanic cavity has been minutely described; the stapes entirely resembles the analogous ossiculum in birds; but the malleus bears a certain resemblance to the same bone in certain of the mammalia. There is reason also to think, that a rudimentary *incus* exists, which, though not quite perfect, is yet sufficiently distinct. From these facts, it is evident, that the analogy supposed to exist between this animal and birds or reptiles, is by no means so strong as has been supposed. We shall presently shew, that the rest of the anatomical details tend considerably to destroy this supposed connection, and to reduce the male ornithorynchus nearly to a mammiferous character.

There is nothing more wonderful in the anatomy of the *ornithorynchus paradoxus*, than the structure of the poison-gland and spur. These organs, which had been previously altogether misunderstood, our author has shewn not to be very complex or difficult of dissection. The poison-gland, which is comparatively large, is situated on either side, almost immediately under the integuments, and over the loins and hip-joint; it transmits a tube of comparatively large calibre, which, after running down the back of the thigh and leg, terminates in a small sack, deep in the hollow of the foot. From this another membranous tube arises, which passes into the spur, and penetrates to its extremity, which is open, to permit the escape of the poisonous fluid which has been secreted by the gland, and which is in this way conveyed into the wounds inflicted by the ornithorynchus on other animals. The whole series of organs resembles, in a certain degree, the poison apparatus of serpents.

The poison-gland is about an inch in length, and five-tenths of an inch in breadth. It is a conglomerate gland, *i. e.* made up of smaller ones, imbedded in a tissue of a different appearance, and which is probably cellular. It lies longitudinally with respect to the spine, covering many of the muscles which rotate the thigh, and may readily be found by merely removing the integuments, *panniculus carnosus*, and a small quantity of loose cellular membrane, lying over the *os innominatum* and hip-joint. An excellent engraving of these organs by Mr Lizars accompanies this memoir.

The Second Memoir contains observations on the organs of digestion and their appendages, and on the organs of respiration and circulation. The author remarks, that these organs generally have been described with extreme accuracy by preceding anatomists, and more particularly by Baron Cuvier; so that he found it difficult, if not impossible, to add much that was novel to their descriptions. He thinks that certain rudimentary grinding teeth, placed anteriorly to the true ones, have been overlooked by some anatomists. A small parotid seems to exist immediately connected with the cheek-pouches; the maxillary gland was very distinct; and its duct, which opens immediately under the tongue, was readily injected with quicksilver. The

salivary glands just described are large, but not disproportionately so.

The anatomy of the other organs treated of in this memoir, shewed generally a decided analogy with the mammalia, with the exception, perhaps, of the heart. In the structure of this organ, there is, undoubtedly, something of an ornithological character; the valves placed at the entrance of the *venæ cavæ* into the right auricle, seemed in a great measure muscular; and the right auriculo-ventricular valve was much more muscular than membranous.

The Third Memoir describes the anatomy of the organs of generation at considerable length; because, next to the poison-gland and spur, it was relative to these organs that the greatest errors had been committed by the Continental anatomists. Our limits do not permit of our entering upon these details, and we shall, therefore, content ourselves with stating, that Dr Knox's dissections have demonstrated the presence of a seminal urethra, distinct from that for the urine; that the seminal fluid, after having been transmitted by the *vasa deferentia* into the urinary canal or true urethra, passes from it by a small circular aperture into a cavity in which terminate the ducts from the glands of Cowper; and that from this common cavity arises the true seminal canal, situated in the body of the penis, and terminating anteriorly by eight conical and pervious papillæ. Most of those facts had been already pointed out by Sir Everard Home, in the Philosophical Transactions, but had been neglected by the Continental anatomists, owing, perhaps, to certain discrepancies observable in his separate memoirs on the subject. We thus see, that a single accurate dissection destroys the whole of those speculations which had arisen out of the supposed peculiarities in the organs of generation; peculiarities thought sufficient to warrant the arranging the ornithorynchus with animals of an entirely opposite structure.

The Fourth Memoir, which treats of the osseous, muscular and nervous systems, contains a lengthened inquiry into the character of the bones composing the shoulder and sternum, which the author in the present state of the science found it impossible to reduce to their analogies in the mammalia. It is here that the structure of the ornithorynchus is most anomalous, and that

it approaches nearest that observed in reptiles. As it would be impossible to do justice to the theoretical views contained in the memoir by any abstract, we shall avoid touching on them. The nervous system is shewn to be quite regular and strictly mammiferous; so that the analogies supposed to connect the ornithorynchus with birds, are proved by these memoirs to be generally forced and inaccurate. Our author has not as yet had it in his power to examine the female ornithorynchus, from a careful dissection of which he anticipates important and decisive results.

ART. XXXII.—*Abstract of Mr* FARADAY'*s Experiments on the Condensation of Several Gases into Liquids.*

THIS very valuable and interesting paper, which will appear in the second part of the Philosophical Transactions for 1822, contains Mr Faraday's Experiments on *Sulphurous Acid*, *Sulphuretted Hydrogen*, *Carbonic Acid*, *Euchlorine*, *Nitrous Oxide*, *Cyanogen*, *Ammonia*, *Muriatic Acid* and *Chlorine*. Although these experiments are scarcely susceptible of abridgment, yet we are compelled, by want of room, to leave out the few parts of the Memoir which are less essential than the rest.

" *Sulphurous Acid.*—Mercury and concentrated sulphuric acid were sealed up in a bent tube, and, being brought to one end, heat was carefully applied, whilst the other end was preserved cool by wet bibulous paper. Sulphurous acid gas was produced where the heat acted, and was condensed by the sulphuric acid above; but when the latter had become saturated, the sulphurous acid passed to the cold end of the tube, and was condensed into a liquid. When the whole tube was cold, if the sulphurous acid was returned on to the mixture of sulphuric acid and sulphate of mercury, a portion was reabsorbed, but the rest remained on it without mixing.

" Liquid sulphurous acid is very limpid and colourless, and highly fluid. Its refractive power, obtained by comparing it in water and other media, with water contained in a similar tube, appeared to be nearly equal to that of water. It does not solidify or become adhesive at a temperature of 0° F. When a tube containing it was opened, the contents did not rush out as with explosion, but a portion of the liquid evaporated rapidly, cooling another portion so much as to leave it in the fluid state at common barometric pressure. It was however rapidly dissipated, not producing visible fumes, but producing the odour of pure sulphurous acid, and leaving the tube quite dry. A portion of the vapour of the fluid received over a mercurial bath, and examined, proved to be sulphurous acid gas. A piece of ice dropped into the fluid instantly made it boil, from the heat communicated by it.

" To prove in an unexceptionable manner that the fluid was pure sulphurous acid, some sulphurous acid gas was carefully prepared over mercury, and

a long tube perfectly dry, and closed at one end, being exhausted, was filled with it; more sulphurous acid was then thrown in by a condensing syringe, till there were three or four atmospheres; the tube remained perfectly clear and dry, but on cooling one end to 0°, the fluid sulphurous acid condensed, and in all its characters was like that prepared by the former process.

"Sulphurous acid vapour exerts a pressure of about two atmospheres at 45° F. Its specific gravity was nearly 1.42.

"*Sulphuretted Hydrogen.*—A tube being bent, and sealed at the shorter end, strong muriatic acid was poured in through a small funnel, so as nearly to fill the short leg without soiling the long one. A piece of platinum foil was then crumpled up and pushed in, and upon that were put fragments of sulphuret of iron, until the tube was nearly full. In this way action was prevented until the tube was sealed. If it once commences, it is almost impossible to close the tube in a manner sufficiently strong, because of the pressing out of the gas. When closed, the muriatic acid was made to run on to the sulphuret of iron, and then left for a day or two. At the end of that time, much protomuriate of iron had formed, and on placing the clean end of the tube in a mixture of ice and salt, warming the other end, if necessary, by a little water, sulphuretted hydrogen in the liquid state distilled over.

"The liquid sulphuretted hydrogen was colourless, limpid, and excessively fluid. It did not mix with the rest of the fluid in the tube, which was no doubt saturated, but remained standing on it. When a tube containing it was opened, the liquid immediately rushed into vapour; and this being done under water, and the vapour collected and examined, it proved to be sulphuretted hydrogen gas. As the temperature of a tube containing some of it rose from 0° to 45°, part of the fluid rose in vapour, and its bulk diminished; but there was no other change: it did not seem more adhesive at 0° than at 45°. Its refractive power appeared to be rather greater than that of water: it decidedly surpassed that of sulphurous acid. The pressure of its vapour was nearly equal to 17 atmospheres at the temperature of 50°.

"The specific gravity of sulphuretted hydrogen appeared to be 0.9.

"*Carbonic Acid.*—The materials used in the production of carbonic acid, were carbonate of ammonia and concentrated sulphuric acid; the manipulation was like that described for sulphuretted hydrogen. Much stronger tubes are however required for carbonic acid than for any of the former substances, and there is none which has produced so many or more powerful explosions. Tubes which have held fluid carbonic acid well for two or three weeks together, have, upon some increase in the warmth of the weather, spontaneously exploded with great violence; and the precautions of glass masks, goggles, &c. which are at all times necessary in pursuing these experiments, are particularly so with carbonic acid.

"Carbonic acid is a limpid colourless body, extremely fluid, and floating upon the other contents of the tube. It distils readily and rapidly at the difference of temperature between 32° and 0°. Its refractive power is much less than that of water. No diminution of temperature to which I have been able to submit it, has altered its appearance. In endeavouring to open the tubes at one end, they have uniformly burst into fragments, with powerful explosions.

"Its vapour exerted a pressure of thirty-six atmospheres, at a temperature of 32°.

" *Euchlorine.*—Fluid euchlorine was obtained by inclosing chlorate of potash and sulphuric acid in a tube, and leaving them to act on each other for 24 hours. In that time there had been much action, the mixture was of a dark reddish-brown, and the atmosphere of a bright yellow colour. The mixture was then heated up to 100°, and the unoccupied end of the tube cooled to 0°; by degrees the mixture lost its dark colour, and a very fluid ethereal looking substance condensed. It was not miscible with a small portion of the sulphuric acid which lay beneath it; but when returned on to the mass of salt and acid, it was gradually absorbed, rendering the mixture of a much deeper colour even than itself.

" Euchlorine thus obtained is a very fluid transparent substance, of a deep yellow colour. A tube containing a portion of it in the clean end, was opened at the opposite extremity; there was a rush of euchlorine vapour, but the salt plugged up the aperture: whilst clearing this away, the whole tube burst with a violent explosion, except the small end in a cloth in my hand, where the euchlorine previously lay, but the fluid had all disappeared.

" *Nitrous Oxide.*—Some nitrate of ammonia, previously made as dry as could be by partial decomposition, by heat in the air, was sealed up in a bent tube, and then heated in one end, the other being preserved cool. By repeating the distillation once or twice in this way, it was found, on after-examination, that very little of the salt remained undecomposed. The process requires care. I have had many explosions occur with very strong tubes, and at considerable risk.

" When the tube is cooled, it is found to contain two fluids, and a very compressed atmosphere. The heavier fluid, on examination, proved to be water, with a little acid and nitrous oxide in solution; the other was nitrous oxide. It appears in a very liquid, limpid, colourless state; and so volatile, that the warmth of the hand generally makes it disappear in vapour. The application of ice and salt condenses abundance of it into the liquid state again. It boils readily by the difference of temperature between 50° and 0°. It does not appear to have any tendency to solidify at —10°. Its refractive power is very much less than that of water, and less than any fluid that has yet been obtained in these experiments, or than any known fluid. A tube being opened in the air, the nitrous oxide immediately burst into vapour.

The pressure of its vapour is equal to above 50 atmospheres at 45°.

" *Cyanogen.*—Some pure cyanuret of mercury was heated until perfectly dry. A portion was then inclosed in a green glass-tube, in the same manner as in the former instances, and being collected to one end, was decomposed by heat, whilst the other end was cooled. The cyanogen soon appeared as a liquid: it was limpid, colourless, and very fluid; not altering its state at the temperature of 0°. Its refractive power is rather less, perhaps, than that of water. A tube containing it being opened in the air, the expansion within did not appear to be very great; and the liquid passed with comparative slowness into the state of vapour, producing great cold. The vapour, being collected over mercury, proved to be pure cyanogen.

" A tube was sealed up with cyanuret of mercury at one end, and a drop of water at the other; the fluid cyanogen was then produced in contact with the water. It did not mix, at least in any considerable quantity, with that fluid, but floated on it, being lighter, though apparently not so much so as ether

would be. In the course of some days, action had taken place, the water had become black, and changes, probably such as are known to take place in an aqueous solution of cyanogen, occurred. The pressure of the vapour of cyanogen appeared to be 3.6 or 3.7 atmospheres at 45° Fahr. Its specific gravity was nearly 0.9.

"*Ammonia.*—When dry chloride of silver is put into ammoniacal gas, as dry as it can be made, it absorbs a large quantity of it; 100 grains condensing above 130 cubical inches of the gas: but the compound thus formed is decomposed by a temperature of 100° F., or upwards. A portion of this compound was sealed up in a bent tube, and heated in one leg, whilst the other was cooled by ice or water. The compound thus heated under pressure, fused at a comparatively low temperature, and boiled up, giving off ammoniacal gas, which condensed at the opposite end into a liquid.

"Liquid ammonia thus obtained was colourless, transparent, and very fluid. Its refractive power surpassed that of any other of the fluids described, and that also of water itself. When the chloride of silver is allowed to cool, the ammonia immediately returns to it, combining with it, and producing the original compound. During this action a curious combination of effects takes place: as the cloride absorbs the ammonia, heat is produced, the temperature rising up nearly to 100°; whilst a few inches off, at the opposite end of the tube, considerable cold is produced by the evaporation of the fluid. When the whole is retained at the temperature of 60°, the ammonia boils till it is dissipated and re-combined. The pressure of the vapour of ammonia is equal to about 6.5 atmospheres at 50°. It specific gravity was 0.76.

"*Muriatic Acid,*—When made from pure muriate of ammonia and sulphuric acid, liquid muriatic acid is obtained colourless, as Sir Humphry Davy had anticipated. Its refractive power is greater than that of nitrous oxide, but less than that of water; it is nearly equal to that of carbonic acid. The pressure of its vapour at the temperature of 50°, is equal to about 40 atmospheres.

"*Chlorine.*—The refractive power of fluid chlorine is rather less than that of water.—The pressure of its vapour at 60° is nearly equal to 4 atmospheres.

Mr Faraday has made many similar experiments on other gases, but though he has not succeeded in condensing any others than those which we have mentioned, yet there is reason to hope that he will ultimately succeed with some of them.

Art. XXXIII.—*Analysis of a Black Mineral from Candy, in Ceylon.* By Dr C. G. Gmelin of Tubingen. (Communicated by the Author.)

This mineral is very hard; it scratches rock-crystal. Its colour velvet-black; its fracture conchoidal; its lustre glassy.

12.145 grammes, when weighed in water, experienced a loss of 3.65 gr., temp. 17° R. The specific gravity of this mineral is therefore 3.617, temp. + 17° R.

Infusible without addition before the blowpipe. Even when reduced to the finest powder, and mixed with spar, it cannot be melted by the most intense heat: it only becomes glassy on the edges. Phosphoric salt takes it up readily, and in large quantity, and melts with it into a translucid greenish glass. By means of nitre, traces of manganese are detected. Borax, in the same manner, melts with it into a greenish glass. When mixed with a little soda, the powder swells up to a yellowish-grey porous mass; but it is impossible to melt it by an additional quantity of soda.

I experienced great difficulty in decomposing it, and my first attempt, by melting it with five times its weight of carbonate of potash, was not perfectly successful. A great deal of the melted mass was left undissolved by muriatic acid. Eight hours were spent in reducing 1.2 grammes of the mineral to an impalpable powder in an agate mortar.

(1.) 1.175 grammes of the dried powder were heated strongly with seven times its weight of carbonate of soda in a platina crucible. The brown melted mass was perfectly dissolved by muriatic acid. The muriatic solution was evaporated to dryness, and the dry mass again dissolved in boiling water, mixed with some muriatic acid. There remained silica, which, after having been heated, weighed 0.03706 gr. = 3.154 per cent. of silica.

(2.) The liquid solution was then mixed with caustic ammonia, and the precipitate was thrown upon a filter, and well washed with boiling water.

(3.) The liquid which had passed the filter gave no precipitate with oxalate of ammonia, but was precipitated by carbonate of potash, when boiled with it. The precipitate in (2.) was boiled with an excess of caustic potash, which dissolved alumina. The residuum was thrown upon a filter, and well washed. The alkaline solution, after having been supersaturated by muriatic acid, was precipitated by carbonate of ammonia. The alumina, when thoroughly washed, was found to weigh 0.6721 gr. = 57.200 per cent. No trace of glucine could be discovered.

(4.) The brown mass (3.) which was left undissolved by caustic potash, was dissolved in muriatic acid, and the solution boiled with some nitric acid. The oxide of iron was then pre-

cipitated by succinate of ammonia; the succinate of iron left, when heated, gave 0.26814 gr. of oxide of iron, = 20.514 per cent. protoxide of iron.

(5.) The solution was then boiled with carbonate of potash, which precipitated carbonate of magnesia. This precipitate, together with that obtained in No. 2. was put upon the same filter. It assumed, after ignition, a reddish colour, which announced some manganese. When dissolved in muriatic acid, there appeared bubbles of carbonic acid gas, and the smell of chlorine was perceived. The solution, therefore, was mixed with sulphuric acid, evaporated to dryness, and exposed to a heat sufficient to drive off the water of crystallization. The dry sulphate of magnesia weighed 0.63 gr., containing 0.214326 gr. magnesia, = 18.240 per cent.

This mineral is therefore composed of

		Contain Oxygen,
Alumina,	57.200	26.712
Protoxide of iron,	20.514	6.219
Magnesia, with a trace of Manganese,	18.240	6.767
Silica,	3.154	
	99.108	

It appears that alumina contains nearly twice as much oxygen as magnesia and oxide of iron together, and that the composition of this mineral may be represented by $MA^2 + fA^2$.

Silica cannot, I think, be considered an essential ingredient of the mineral; its quantity is very small, and, considering the hardness of the stone, the greater part of it may fairly be deduced from the agate mortar.

The specimens of this mineral, for which I am indebted to the liberality of my friend Mr Heuland, were massive, and there is sufficient ground, on account of the chemical composition, and the external characters of this mineral, to consider it as Spinel; it may be ranged in the system as *Massive Pleonast* *.

* We are informed that Count Bournon, in a late memoir, describes this mineral under the name *Candite*. Mr Heuland also furnished Laugier with specimens, but his analysis has not reached this country.—Ed.

ART. XXXIV.—*Celestial Phenomena, from October* 1. 1823 *to January* 1. 1824, *calculated for the Meridian of Edinburgh, Mean Time, with Observations on the Lunar Eclipse of the 23d July.* By Mr GEORGE INNES, Aberdeen.

THE weather, during the month of July, was very unfavourable here for making astronomical observations; and the Solar Eclipse of the 8th was invisible. As I felt anxious to obtain, if possible, the advantage of a clear atmosphere, in order to observe the Total Eclipse of the Moon on the 23d of July, in company with two friends I went about six miles southward; and fortunately the atmosphere, towards the commencement of the eclipse, became sufficiently clear, and the beginning was observed at $1^h\ 27'\ 16''$, and the commencement of total darkness at $2^h\ 34'\ 14''$, Aberdeen mean time, after making an allowance for the error of the clock by which my pocket chronometer was set. The telescope used magnified about twenty-five times.

From the beginning of the eclipse, till near the time of total darkness, the moon was occasionally hid by clouds; the shadow was pretty well defined, until about 6′ before the total obscuration, after which it became more and more jagged.

For about 2′ before the commencement of total darkness, the unobscured limb of the moon appeared dilated beyond the other part of her circumference; and during this period, the unobscured part of her disc assumed a white appearance, tinged with green.

The penumbra was not so sensible as that of the eclipse of February 1822, and hence the time of the beginning of this eclipse was more easily determined; but the time of total obscuration may be estimated at about 15″ earlier than observation, owing to the refraction of the last portion of the unobscured part of the disc, towards the commencement of total darkness.

The dark body of the Moon was visible for about half an hour after the total obscuration, when, from the approach of dawn, and the Moon's entering a very slight cloud, we lost sight of her.

It was particularly observed, that after, as well as before the total obscuration, the east part of the Moon's dark disc appeared much fainter than the west; but we were unable to trace this appearance till she was in the centre of the shadow, from the above circumstances.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension*, instead of *Longitude* as formerly.

October.

D	H	′	″	
2.	23	58	30	Im. III. sat. ♃
3.	5	15	51	Im. I. sat. ♃
4.	8	12	43	● New Moon.
	23	44	9	Im. I. sat. ♃
5.	1	36	13	☌ ☽ ♀
6.	2	45	0	☌ ☽ ☿
8.	2	46	9	☌ ☽ π ♏
	16	12	3	☌ ☽ α ♏ *
10.	2	34	38	Im. II. sat. ♃
	21	5	47	☌ ☽ λ ♐
11.	5	18	0	☌ ☽ ♅
12.	1	37	29	Im. I. sat. ♃
	1	41	12	☽ First Quarter.
17.	5	10	55	Im. II. sat. ♃
19.	3	30	48	Im. I. sat. ♃
	21	43	3	○ Full Moon.
20.	21	59	10	Im. I. sat. ♃
21.	19	32	0	☌ ☽ ♄
	22	27	42	☌ ☽ f ♉
24.	4	51	0	⊙ enters ♏
25.	0	38	40	☌ ☽ ι ♊
	6	39	40	☌ ☽ ♃
26.	0	17	19	Em. III. sat. ♃
	0	41	41	☌ ☽ κ ♊
	5	24	7	Im. I. sat. ♃
	19	15	6	☾ Last Quarter.
27.	2	4	53	☌ ☽ δ ♋
	23	6	38	☌ ☽ ξ ♌
	23	53	28	Im. I. sat. ♃
	28	13	30	☌ ☽ ♂

November.

D	H	′	″	
1.	13	53	0	☌ ☽ ♀
2.	1	18	58	Im. III. sat. ♃
	4	17	27	Em. — —
	9	47	0	☌ ☽ ☿
	21	10	32	● New Moon.
3.	23	41	27	Im. II. sat. ♃
4.	2	45	48	Im. I. sat. ♃
	21	7	56	☌ ☽ σ ♏
				☿ greatest elong.
5.	0	44	3	☌ ☽ α ♏
	20	53	47	☌ ☽ A Oph.
	23	50	16	☌ ☽ ϑ Oph.
7.	15	3	0	☌ ☽ ♅
9.	5	17	2	Im. III. sat. ♃
10.	22	23	36	☽ First Quarter.
11.	2	18	4	Im. II. sat. ♃
	3	39	10	Im. I. sat. ♃
12.	0	55	23	☌ ☽ ϑ ♒
	22	7	31	Im. I. sat. ♃
18.	1	0	0	☌ ☽ ♄
	4	54	48	Im. II. sat. ♃
	5	32	35	Im. I. sat. ♃
	9	53	39	○ Full Moon.
20.	0	0	57	Im. I. sat. ♃
21.	12	0	0	☌ ☽ ♃
	21	44	4	☌ ☽ δ ♊
23.	1	19	0	⊙ enters ♐
	3	7	19	☾ Last Quarter.
26.	5	12	0	☌ ☽ ♂
	20	0	17	Im. III. sat. ♃
	20	37	1	Em. — —
27.	1	51	28	Im. I. sat. ♃
28.	18	29	0	☌ ☽ ♀
	20	22	51	Im. I. sat. ♃
	20	50	38	Im. II. sat. ♃
30.	20	13	2	Em. III. —

---

* The following are the results of the calculations for the occultation of *Antares* by the Moon, for Greenwich and Aberdeen:

Greenwich,	Immersion, October 8.	16h 12′ 29″.0,	at 2′ 17″.3 N. of ☽'s centre.
	Emersion, ——— —	17 32 16.9,	at 0 34.8 S. of ☽'s centre.
	Moon's southing,	15 10 0	
Aberdeen,	Immersion, October 8.	15h 58′ 4″.6,	at 3′ 6″.9 N. of ☽'s centre.
	Emersion, ——— —	17 14 31.8,	at 0 46.3 N. of ☽'s centre.

DECEMBER.

D	H	′	″	
1.	23	50	0	☌ ☽ ☿
2.	13	12	58	● New Moon.
4.	3	48	4	Im. I. sat. ♃
5.	1	11	6	☌ ☽ 1 υ ♐
	1	20	48	☌ ☽ ♅
	22	16	29	Im. I. sat. ♃
	23	37	25	Im. II. sat. ♃
7.	21	12	29	Im. III. sat. ♃
8.	0	14	20	Em. — —
10.	22	32	33	☽ First Quarter.
11.	5	41	48	Im. I. sat. ♃
13.	0	10	14	Im. I. sat. ♃
	2	4	39	Im. II. sat. ♃
15.	1	11	14	Im. III. sat. ♃
	4	13	58	Em. — —
	8	13	0	☌ ☽ ♄
16.	0	22	37	☌ ☽ η ♉
17.	21	33	16	○ Full Moon.
18.	16	58	0	☌ ☽ ♃
				☿ greatest elong
20.	2	4	6	Im. I. sat. ♃
	4	41	47	Im. II. sat. ♃
21.	20	32	36	Im. I. sat. ♃
22.	0	36	28	☌ ☽ π ♌
	5	9	57	Im. III. sat. ♃
	14	0	0	☉ enters ♑
23.	17	59	51	Im. II. sat. ♃
	21	49	10	☌ ☽ υ ♌
24.	10	2	0	☌ ☽ ♂
	13	5	26	☾ Last Quarter.
27.	3	58	5	Im. I. sat. ♃
28.	3	31	0	☌ ☽ ♀
	22	26	37	Im. I. sat. ♃
29.	1	4	17	☌ ☽ π ♏
30.	19	7	4	Em. I. sat. ♃
	23	21	52	Em. II. sat. ♃

Georgium Sidus.—This planet was observed here on the evenings of the 20th and 22d of August, about the time of his passing the meridian, with Mr Ramage's 25 feet reflecting telescope; but owing to the glare of moonlight, and the hazy state of the atmosphere in that quarter, only 3 of his satellites could be distinctly seen.

ART. XXXV.—*Proceedings of the Wernerian Natural History Society.* (Continued from p. 188)

May 3. 1823.—THE Secretary read Dr Ramsay's *Account of Macquarrie Island, and of the Sea-Cow Chase,* for which it is frequented; and Dr Fleming's *Observations on some species of Vermiculum.* Mr Arnott read some extracts from Mr William Jameson's *Journal of a Voyage round Cape Horn,* and presented an account of several new Musci, sent from South America by Mr Jameson. Lastly, the Secretary read the concluding part of Dr Rusconi's paper, *On the Natural History of the Aquatic Salamander.*

May 17.—The Secretary read Professor Hansteen's *Observations made on a Journey from Christiania to Bergen, across the high mountains.* Dr Knox read a Memoir on the *Organs of Sense, and the Anatomy of the Poison-Gland and Spur, of the Ornithorynchus paradoxus of New Holland.* Dr Hibbert read a *Notice regarding a Mineral lately found at Papa Stour in Shetland.* And Mr Parry exhibited the Fossil Head of a very large Wild Boar, found imbedded in a peat-moss in Berkshire.

May 31.—The Secretary read, 1. Mr Wilkinson's *Memoir on the Geographical Distribution of Plants in Yorkshire*; 2. Dr Thomas Barne's *Biographical Notice of Mary Noble of Penrith, now in the* 107*th year of her age, with some general remarks on Longevity*; and, 3. Dr T. S. Traill's *Description of a new species of Regulus* (Motacilla) *from Brazil*, illustrated by a drawing.

At the same meeting, Professor Jameson read the Rev. H. F. Borgesen's *Description of Vettie's Giel*, a very remarkable and nearly inaccessible dell in Norway. (This paper is printed in the present number of the Journal, p. 299. *et seq.*)

June 14.—The Secretary read, 1. The continuation of Dr Fleming's *Voyage round the North of Scotland in* 1821; 2. Notices regarding the *Migration of the Woodcock*, by Major Morrison; and, 3. A *Memoir on the power possessed by some species of Spiders of ascending into the air*, by Mr John Murray, F. L. S.

There were then communicated to the Society the results of a series of Themometrical Observations made hourly at Leith, *during twenty-four successive hours*, once every month, from July 1822 to July 1823, by Mr Coldstream of Leith, assisted by his sister.

At the same meeting, Professor Jameson read Dr Boué's answer to M. Beudant's opinion regarding the crystalline rocks of the Red Sandstone formation, as explained in the 3d volume of his "Voyages en Hongrie." Also, the first part of a learned and elaborate Commentary on the "Herbarium Amboinense," by Dr Francis Hamilton of Leny.

The Society adjourned its meetings till November.

Art. XXXVI.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *History of the Rediscovery of Encke's Comet.*—The merit of the rediscovery of this comet, which we mentioned in our last number, and which has excited great interest, is due to our countryman, Mr James Dunlop, an ingenious maker of telescopes, from Ayrshire, who went out to New South Wales, with his Excellency Sir Thomas Brisbane, as a scientific assistant. Mr Dunlop was examining the heavens with a sweeper, when he encountered this singular body. We state this fact on the authority of Sir Thomas Brisbane *, who has recently transmitted to the Royal Society of Edinburgh, a series of valuable astronomical observations made at Paramatta. It is impossible to speak too highly of the zeal and talents of this eminent astronomer, whose appointment to the government of New South Wales has given such universal satisfaction.

2. *Longitude and Latitude of Paramatta.*—The longitude of the observatory of Paramatta, in New South Wales, is $10^h\ 4'\ 14''.5$ east of Greenwich, as determined by various methods of observation. The latitude of the observatory is $33°\ 48'\ 42''$.

3. *New Elements of Encke's Comet.*—The following correct elements of this comet have been given by M. Encke:—

Passage of the Perihelion, 1822, May 24, .01768, Mean time at Seeberg.

Long. of the Perihelion,	.	157° 11′ 28″.8	From Mean Equinox.
———— Node,	.	331 19 31 .9	
Inclination of the Orbit,	.		
Excentricity,	. .	0.8445479	
Its Sine,	. . .	57° 37′ 24″.7	
Log. of one-half the greater Axis,		0.3472191.	

M. Encke is engaged in very laborious calculations, with the view of ascertaining if the resistance of the ether could have any

* Great credit is due to Sir Thomas, in doing this justice to our modest countryman. Baron de Zach, who considers the rediscovery of this comet as one of the greatest efforts of modern astronomy, ascribes all the glory of it to the "vigilant and penetrating eye of M. Rumker," and to "Germanic diligence." M. Rumker has great merit in every thing he does, and particularly in what he has done on this subject; but the merit of discovering the comet is solely Mr Dunlop's.

influence in causing the diminution which has been observed in its periodical time.—See Zach's *Corresp. Astron.* vol. viii. p. 279.

4. *Observatory of Dorpat in Livonia.*—This observatory, under the direction of M. Struve, an able and active astronomer, has been supplied, in the most handsome manner, with fine instruments, by the Emperor of Russia, whose liberality to science deserves the highest encomiums. M. Frauenhofer of Munich has been occupied for two years in completing, for this observatory, an achromatic telescope, *fourteen feet in focal length, and with an aperture of nine inches.* "You may judge from this," says M. Struve, in a letter to Baron de Zach, "how much our liberal government does for astronomy. Our observatory is particularly indebted to the curator of our University, M. General Comte de Lieven, who has not only provided it with every thing that is excellent and perfect in the way of instruments, but has also built a commodious house for the astronomer. He has likewise ordered a great meridian circle, similar to that of Gottingen, Munich, and Konigsberg; a great repeating circle; and an universal instrument, &c. all from the manufactory of MM. Reichenbach and Ertel of Munich."—Zach's *Corres. Astron.* vol. viii. p. 370.

5. *Measurement of a Degree in Livonia.*—The liberality of the Russian Government has also been shewn, in charging M. Struve of Dorpat, with the measurement of a degree of the meridian, in Livonia. Properly speaking, this work is carried on by the University, out of the large funds which the Government has put at its disposal, for every purpose that is useful and interesting to science. M. Struve began his operations in the summer of 1822.

6. *Eclipse of the sun of 7th February* 1823, *observed at Bushy Heath.* The end of this eclipse was observed by Colonel Beaufoy, at $17^h\ 44'\ 30''$.—Mean time at Bushy, in West Long. $1°\ 20''.93$, and North Lat. $51°\ 37'\ 44''.3$.

7. *Rev. Dr Pearson's Introduction to Practical Astronomy.*—The Rev. W. Pearson, LL.D., Treasurer of the Astronomical Society of London, has nearly finished printing a quarto volume of astronomical tables, which will constitute Vol. I. of "An Introduction to Practical Astronomy," and which will save the practical astronomer much trouble, by facilitating the reductions

of his observed places of the heavenly bodies, as well as in adjusting the position of his instruments, and deducing his correct time. The second volume will contain an account of the various instruments at present used in making astronomical observations, illustrated by numerous engravings by Turrell, done in his best manner; and the methods of using the instruments will be exemplified by applying the corrections, derived from the Tables, to real observations made with the instruments described. A work like this has been long wanted; and we know of no person better qualified, by his talents and his practical knowledge, for such a work, than Dr Pearson. The council of the Astronomical Society have given the author permission to have his labours dedicated to its President, Vice-President, and Members.

8. *Changes in the Declinations of some of the Fixed Stars.*—In the *Phil. Trans.* for 1823, part I., Mr Pond has published a series of observations, from which he deduces a change of declination southwards, which is not explained by the received doctrines of astronomy. This discovery will be a most important one, if Mr Pond confirms it by his future observations; but we understand that this anomaly is not deducible from the contemporaneous observations of that able astronomer, the Reverend Dr Brinkley.

OPTICS.

9. *Paranthine and Wernerite.*—Although these two minerals have been given in Treatises on Mineralogy as different species, yet mineralogists have conjectured, that, from the similarity of their crystalline forms and chemical composition, their identity would be proved by future analyses. Dr Brewster has lately examined the optical structure of the Paranthine from Christiansand in Norway, which Dr Forchhammer of Copenhagen was so good as to send him for this purpose, and has found it to be the same as that of Wernerite. It has one axis of double refraction, coincident with the axis of the square based prism, in which it crystallises. The action of this axis is negative, like that of Wernerite, and the character of the tints is exactly the same.

10. *On the Defective Vision of the Horse.*—The following very curious facts are mentioned by Dr Knox, in his valuable

paper on the Comparative Anatomy of the Eye, lately communicated to the Royal Society of Edinburgh. "I observed a very singular fact in Africa, which first awakened my suspicions relative to the defective vision of the horse. In that country we were forced, from a deficiency of pasturage, to allow our horses to graze at perfect liberty on the open desarts, and they, so situated, seemed to acquire many of the habits which the animal would probably possess in a perfectly wild state. They grazed generally in small troops, to which an entire horse, or one of the boldest of the geldings, seemed to serve as protector; on the approach of strangers, the troop immediately collected into a circle, and remained so until the horse appointed to watch over the general safety had ascertained whether or not danger was to be apprehended, by a nearer approach of the object suspected. On one occasion, having gone into the fields with a few friends, of whom one was dressed in a morning gown, and, coming unexpectedly on the troop of horses, they were observed to collect immediately into a circle, and to detach one of their number, with a view to ascertain the nature of the very unusual appearance, which they evidently saw but indistinctly, though scarcely three quarters of a mile removed from the place where we stood. It was now I remarked, with some surprise, that the horse did not, during the very long and circuitous course, approach much nearer us, but made hastily for that situation in which we should be placed between him and the quarter from whence the wind blew; thus evidently employing the organ of smell in preference to that of sight."

ACOUSTICS.

11. *On the Polarisation of Sound.*—The following curious facts, which are considered to prove the Polarisation of Sound, are given by Mr Wheatstone, in the Annals of Philosophy, No. xxxii. p. 87.

"I connected," says he, "a tuning fork with one extremity of a straight conducting rod, the other end of which communicated with a sounding-board; on causing the tuning fork to sound, the vibrations were powerfully transmitted, but in gradually bending the rod, the sound progressively decreased, and was scarcely perceptible when the angle was a right one. As the angle was made more acute, the phenomena were produced in an inverted

order; the intensity gradually increased as it had before diminished, and when the two parts were nearly parallel, it became as powerful as in the rectilineal transmission. By multiplying the right angles in a rod, the transmission of the vibration may be completely stopped."

In these experiments, the axis of the oscillations of the tuning fork should be perpendicular to the plane of the moveable angles; for if they are parallel, they will still be transmitted. Mr Wheatstone gives the following explanation to prove this. "I placed a tuning fork perpendicularly on the side of a rectilineal rod. The vibrations were therefore communicated at right angles; when the axis of the oscillations of the fork coincided with the rod, the intensity of the transmitted vibrations was at its maximum. In proportion as the axis deviated from parallelism, the intensity diminished, and when it became perpendicular, the intensity was a minimum." The phenomena of polarisation may be observed in many chorded instruments. The chords of the harp are attached to a conductor which has the same direction as the sounding-board; if any chord be altered from its quiescent position, so that its axis of oscillation shall be parallel with the bridge or conductor, its tone will be full; but if the oscillations be excited, so that their axes shall be at right angles with the conductor, the tone will be feeble.

12. *On the Oscillations of Sonorous Chords.*—The following theorem on this subject is very important in acoustics, and removes all obscurity from the subject of harmonic sounds.

"If any two sonorous chords A and B be so placed, that the oscillations of one shall cause the air to act upon the other, as in all stringed musical instruments; and if A oscillates *m* times, while B oscillates *n* times, *m* and *n* being any whole numbers prime to each other; then if either of the chords, as A, is put in motion, the action of the air will divide B into *m* equal parts, which will oscillate *n* times, while A oscillates only once."—*Quarterly Journal*, No. xxx. p. 374.

ELECTRICITY.

13. *Improvement on the Electrical Machine.*—Having remarked the great efficiency of electrical machines, when a hot cloth was held under the cylinder, and observed, that this additional power lasted only while it continued warm, Mr Ronalds

conceived the idea of keeping the rubber hot, by fixing it in a hollow half cylinder of copper, supported by a hollow copper tube, at the lower end of which was placed a small spirit lamp, whose burner consists of only one thread of cotton. The prime conductor was also heated in a similar manner, being supported by a hollow glass tube, at the bottom of which another small spirit-lamp was placed. Mr Ronalds remarks, that a cylinder machine thus constructed is always effective. He supposes, that heat assists the excitement, by promoting the oxidation of the amalgam.—Ronalds *on an Electrical Telegraph*, p. 25. Lond. 1823.

14. *On the Production of Electricity by Pressure.*—From a series of experiments on this subject, M. Becquerel concludes, that all bodies assume two different electric states by pressure;—that in two bodies which are perfect conductors, this state of equilibrium ceases the moment the pressure is removed, but if one be a bad conductor, the effect of the pressure continues for a longer or a shorter time; that the pressure alone maintains the equilibrium of the two fluids placed in each of the surfaces, for if the pressure be diminished, and at the end of a certain time, the bodies be removed from the compression, they will be found to have the electricity due only to the remaining pressure; that heat modifies the development of electricity in a particular manner; that the intensity of the electricity increases, at first, directly as the pressure, and that it is probable this proportion diminishes at high pressures, as the bodies lose their power of being compressed. Finally, it is rendered probable, that the light which is disengaged in powerful concussions, is due to the rapid recombination of the two electricities developed on the surfaces, at the moment of compression.—*Quarterly Journal*, No. xxx. p. 368.

15. *Development of Electricity by two pieces of the same Metal.*—M. Avogrado has discovered, that if two pieces of the same metal are plunged, at different instants, into an acid, which acts upon them, the piece first introduced will act as the most positive metal to the other.

MAGNETISM.

16. *Improved Ship's Compass.*—Lieutenant Littlewort, has contrived a method, by which the ordinary hanging compass may be converted into an azimuth compass, so that the masters of merchant vessels may have the benefit of this last instrument, with which they are seldom supplied. The handle by which the compass is suspended to the roof of the cabin, is capable of being inverted, and of supporting the compass, by sliding in a groove made in a box, which box is capable of motion on a central pin fixed in the board on which the box stands; moveable sights and a stop are also annexed, to enable it to act when required as an azimuth compass. A drawing and description of this compass, will be found in the *Transactions of the Society of Arts*, vol. xl. p. 70.

MECHANICS.

17. *Mr Babbage's Calculating Machinery.*—We have much pleasure in informing our readers, that Government have, in the handsomest manner, advanced L. 1500 to Mr Babbage, to complete one of his calculating machines on a large scale.

METEOROLOGY.

18. *Remarkable Balls of Snow at Brunswick.*—On the 1st of April 1815, Professor Cleveland observed a great number of balls of snow, from 1 to 15 inches in diameter, the small ones being nearly spherical, and the larger ones somewhat oval. Their texture was homogeneous, and they were extremely light, consisting of minute prisms of snow, irregularly aggregated. These balls were formed by having been rolled a considerable distance by the wind, their paths being in general distinctly visible. The smaller balls, however, were decidedly formed in the atmosphere, as they occurred in woods and in small inclosures.—Professor Silliman's *Journal*, vol. vi. p. 169.

19. *Quantity of Rain in America.*—The following observation on the quantity of rain which fell in West Chester, Pennsylvania, were made by Dr Darlington.

1818, - - -	48.83 Inches.
1819, - - -	31.12
1820, - - -	43.5
1821, - - -	52.6
1822, - - -	39.3
Average of Five Years, -	43.07

Prof. Silliman's *Journal*, vol. iv. p. 327.

20. *On the Periodical reappearance of Thunder-Storms.*—That celebrated philosopher Count Volta remarked the extraordinary tendency which thunder-storms have to reappear many days successively about the same hour, and, what is still more remarkable, at the precise spot where they at first appeared. "It is necessary," says Volta, "to inhabit a mountainous country, and particularly the neighbourhood of lakes, such as Como, the precincts of Lario, Verbano, Varese, Lugano, Lecco, and the whole mountains of Bianza, Bergama, &c., in order to be convinced of such periods and fixations (so to speak) of thunder-storms at this or that valley, or opening of a mountain, which last, until some wind or remarkable change in the atmosphere shall occur to destroy them." Count Volta ascribed this very remarkable phenomenon to a modification in the ambient air produced by the thunder-storm of the preceding day.—Configliachi's *Giornale di Fisica*, quoted by Mr Ronalds.

21. *Periodical Rise and Fall of the Barometer.*—Colonel Wright, Member of the Ceylon Literary and Agricultural Society, is said to have discovered, that within the Tropics the mercury rises and falls twice within 24 hours, with such regularity as to afford almost an opportunity of measuring the lapse of time by this instrument.—*Ceylon Government Gazette.*

22. *Influence of Atmospheric Pressure on the Bulbs of Thermometers.*—In a preceding Number, vol. viii. p. 397. and vol. ix. p. 196., we have noticed the observations of MM. Flauguergues, Bellani, and Professor Moll on this subject. The observations of M. Flauguergues, induced two young and ingenious chemists of Geneva, MM. Aug. De la Rive, and Francis Marcet, to examine the subject with considerable attention. The following are the general results of their experiments.

1. That atmospheric pressure influences the size of the bulbs of thermometers.
2. That thermometers open at their upper extremity should be used in cases where this influence may be sensible.

3. That, on taking this influence into account, there is a production of cold in making a vacuum, though to a less degree than has hitherto been supposed.
4. That during the admission of air, and the gases, into a receiver void of air, there is at first a production of cold, then in proportion as the air condenses itself more in the interior of the receiver, there is a production of heat, a fact which the authors consider of more importance, as it has hitherto been supposed that heat alone is produced.
5. That various modifications may render more intense the cold produced at the admission of air into the vacuum.—See *Bibl. Univers., Avril* 1823.

23. *Whirlwind at Scarborough.*—Major W. M. Morison has communicated to us the following notice of a whirlwind he observed at Scarborough.—" In the afternoon of Tuesday the 24th of June 1823, the formation of a whirlwind was noticed about a mile to the westward of Scarborough. Its direction was east, and passing by a plantation within a quarter of a mile of the town, it tore up two large elm-trees. It then proceeded along the road which is between the Cliff and the Spaw, and leading to the sands, at the bottom of which about thirty bathing-machines were arranged, and, it being nearly high-water at the time, nine of these were driven into the sea, and several were overturned and broken by its violence. One machine, in particular, which appeared more under its influence than the rest, was observed to be whirled round several times, and with such force as to break off its wheels. A little farther, two boats were at anchor, a few yards only apart: one of these it drove to some distance along the shore, in a direction contrary to its course; the other boat remained stationary. It then entered the harbour, where it forced three large vessels from their moorings, and overturned four boats; fortunately, however, without the loss of a single life, it finally passed over the pier into the sea, where it suddenly disappeared. A person who was on the road when the whirlwind passed, compared the sound of its approach to that produced by the rattling of several heavy carriages together. Its shape was spiral, its breadth, at the base, seemed to vary from about sixty to eighty yards, and its height appeared to be about seven hundred feet. When it reached

the sea, it agitated and raised the water to the height of twenty feet as it advanced; the spray in its beautiful whiteness strongly resembling a drift of snow. A very short time previous to the appearance of this phenomenon, there had been lightning with some thunder, accompanied with heavy showers of rain, and the wind, which was south-west, was suddenly changed, preceded by the whirlwind, to the westward*."

24. *Extraordinary depression of the Barometer in February 1823.*—On the 2d of February 1823, at $11^h\ 34'$ A. M., M. Flauguergues observed the barometer at Viviers to be so low as 26 inches 7.20 lines French measure, which is 3.23 lines lower than he observed it on the 25th December 1821. M. Nell de Bréauté, at La Chapelle near Dieppe, observed it at the lowest, on the same day, at $4^h\ 30'$ in the morning, when it was 714.73 millimetres. M. D'Hombres Firmas observed it at Alais, to be at the lowest, 26 inches 4 lines, on the 2d February, at $10^h\ 15'$ A. M., or three lines lower than on the 25th December 1821. At Paris, the barometer stood at 722.34 millimetres, on the 2d February, at noon.—See *Bibl. Univers.*, Juin 1823, p. 99.; and Juillet, p. 170 and 178.

II. CHEMISTRY.

25. *Observations on the Two New Fluids in Minerals.*—Although we are not in the habit of criticising the speculations of our fellow-labourers in science, yet there is a passage in the last number of the *Journal of Science of the Royal Institution* which the interests of science require us to notice.

After reprinting the notice respecting the two new fluids, published in p. 400. of our last number, the learned Editor of the Journal above quoted adds the following observations.

" We have seen a most curious and satisfactory specimen of amethyst-quartz, containing the fluid above described by Dr Brewster, in the collection of Thomas Allan, Esq. of Edinburgh. It exhibits three distinct oblong cavities, which, when the crystal is very slightly warmed, are, to all appearance, *empty*; but, upon cooling it by immersion in water, or by holding it against any cold substance, a portion of liquid is immediately

* A fuller account of this phenomenon was sent to us by Mr Dunn, but unfortunately it has not yet reached us.—ED.

perceived in each of the cavities, which gradually *disappears* as the crystal becomes less cold. The appearances are such as one might expect would arise from very highly condensed carbonic acid contained in the bubbles, assuming alternately the liquid and gaseous form, by very slight elevations and depressions of temperature.—Ed."

As the preceding description of Mr Allan's specimen appears to us quite the reverse of that given by Dr Brewster, we shall here state how the case actually stands. When the crystal is very slightly warmed, the three oblong cavities, mentioned above, *are actually filled with a liquid*, as may be seen by its gradually rising till it fills the cavity; but, upon cooling the crystal, the liquid contracts in dimensions, and a bubble, either of vacuity or gas, occupies about *one-third* of the cavity. That the fluid is not a condensed gas, in the usual sense of the word, is certain, because it retains its fluidity when in the open air, and leaves a residuum behind it after evaporation. Mr Allan's very fine specimen contains *both the new fluids* discovered by Dr Brewster, but it requires particular methods of observation to see the second one.

26. *Crystallisation of Acetic Acid by Pressure.*—Mr Perkins, we understand, has succeeded in crystallising acetic acid by the pressure of 1000 atmospheres. The transparent crystals thus formed are pure acid; and the residuum is acidulous water. Mr Perkins has crystallised several other acids by the same means.

27. *Conversion of Atmospheric Air into a Fluid by Pressure.*—Mr Perkins has, we learn, compressed atmospheric air to such a degree, that a small portion of fluid appears at the end of the compressed column. This fluid does not wholly recover its gaseous state when the pressure is removed. It was supposed to be water, but this is not yet certain; several other gases have been converted into liquids by the same powerful agency.

28. *Persulphate of Iron and Ammonia.*—This triple salt was obtained by Dr Forchhammer of Copenhagen, in the following manner. Having prepared a solution of gold by means of nitric acid, and muriate of ammonia, and precipitated the gold by protosulphate of iron, the clear solution was concentrated to a syrupy consistence. After remaining a month, fine wine-yellow

octohedral crystals were formed on the sides of the vessel. This salt dissolves in three parts of water at 60°, and may be obtained perfectly colourless, by repeated crystallisation. Upon analysis, Dr Forchhammer found it to consist of

		Atoms.
Persulphate of Iron,	41.95	3
Sulphate of Ammonia,	12.11	1
Water,	45.94	24

Ann. of Phil. vol. v.

29. *Boracic Acid in Tourmaline.*—Mr Henry Seybert has discovered the boracic acid in the *green tourmaline,* from Chesterfield, Massachusets; in the *rubellite* and *indicolite,* from Massachusets, and in the *black tourmalines* from Haddam, Connecticut, and Chester Creek, Delaware County.—Professor Silliman's *Journal,* vol. vi. p. 155.

30. *Varying quantity of Boracic Acid in Tourmaline.*—Dr Gmelin of Tubingen has found, in all tourmalines which he has hitherto analysed, a varying quantity of boracic acid. He found it to be so even in the *Common Schorl* from Eibenstock in Saxony, analysed by Klaproth. The alkaline bases are a mixture of potash and soda, or of potash and lithion. Many of them contain a considerable quantity of magnesia. The variety *Rubellite* of Moravia, in whch Klaproth and Bucholz announced 7—9 per cent. of soda, does not contain a trace of this alkali, but a mixture of boracic acid, potash and lithion. According to him, the *Rubellite* is composed of

Boracic Acid,	5.744
Silica,	42.127
Alumina,	36.430
Oxide of Manganese, with a trace of Iron,	6.310
Lime,	1.200
Potash,	2.405
Lithion,	2.043
Volatile Matter,	1.313
	97.582

31. *Professor Silliman's Additional Observations on the Fusion of Carbonaceous Bodies.*—Professor Silliman has lately found that melted charcoal has its conducting power greatly reduced by fusion, and that the globules of melted plumbago are as absolute nonconductors of heat as the diamond. The globules of

melted anthracite are also perfect nonconductors, which may be conceived less remarkable, since the ordinary anthracites have very little conducting power; but the Rhode Island anthracite conducts as well as plumbago, and its globules are perfect nonconductors. Professor Silliman remarks, "that it will now probably not be deemed extravagant, if we conclude that our melted carbonaceous substances approximate very nearly to the condition of the diamond."—*Amer. Journal*, vol. vi. p. 378–9.

32. *Dr Wollaston on Metallic Titanium.*—Dr Wollaston's attention was directed by Professor Buckland to certain very small cubes, having the lustre of burnished copper, that occasionally occurred in the slag of the iron-works at Merthyn Tydvil. These cubes had been considered pyritical; but Dr Wollaston has found that they are metallic titanium, with a specific gravity of 5.3. "From the extreme infusibility of these cubes," says Dr Wollaston, "it seems probable that they have not been formed by crystallisation in cooling from a state of fusion; but have received their successive increments by reduction of the oxide dissolved in the slag around them; a mode of formation to which we must have recourse for conceiving rightly the formation in nature of many other metallic crystals." —*Phil. Trans.* 1823, part 1.

33. *Acid Earth of Persia.*—This singular substance, some of which was brought to England by Lieutenant-Colonel Wright, is found in great quantities at a village called Doulakie, in the south of Persia, between three or four days' journey from Bushire. It is used by the natives to make their sherbets. Mr Pepys has found that it contains sulphuric acid.—*Phil. Mag.* No. 303, vol. lxii. p. 75.

34. *Bitumen, and a Volatile Fluid in Minerals.*—The Right Honourable George Knox, has lately communicated to the Royal Society a paper in which he shews that bitumen may be obtained by distillation in a proper apparatus, from a variety of minerals, such as basalt, greenstone, serpentine, mica, &c. Mr Knox has also found another fluid substance of a highly volatile nature; but he has not yet examined it.

35. *Native Sulphate of Iron and Alumina.*—This salt found in the slate-clay at Hurlet and Campsie in Scotland, is composed, according to Mr R. Philips, of

Sulphuric acid,	30.9	4 Atoms.
Protoxide of Iron,	20.7	3
Alumina,	5.2	1
Water,	43.2	25
	10.0	

Ann. of Phil.

36. *Iron Malleable immediately from the Furnace.*—Mr Russell has laid before the Literary and Agricultural Society of Ceylon, a report on the subject of smelting the iron of that country. "The extraordinary and valuable quality, it is remarked, possessed by this metal, in being malleable immediately from the furnace, will probably attract attention among our manufacturers at home, to whom such a property must in many instances prove inestimable."—*Ceylon Government Gazette.*

37. *Experiments on Palladium.*—M. Breant, who had discovered a method of purifying and melting platinum, was employed to treat the platinum which the Spanish Government had collected since the discovery of the metal in 1741. The quantity was more than 1000 kilogrammes, or twenty quintals; and from this he obtained a quantity of palladium, which enabled him to examine its properties. The colour of palladium is like that of silver, and its ductility is the same. Its specific gravity is 12. Its fusibility is nearly equal to that of iron. Air and water do not alter it. At a dark red heat, it takes a reddish violet tint, which passes to blue; but by increasing the heat it resumes its metallic lustre. A mixture of nitric and hydrochloric acid dissolves it even when cold. It unites easily with the metals. The alloys are generally ductile. A very small quantity discolours gold entirely. It combines with mercury, sulphur, and probably with carbon. If this metal were more common, (its price is about six times that of gold), it might be employed for medals and chemical vessels, and it might be used in place of silver in some articles of jewellery.—*Bibl. Univers.*, Juillet, p. 236.

III. NATURAL HISTORY.

MINERALOGY.

38. *Sale of the Collection of Minerals of the late Abbé Haüy.*—This magnificent collection, consisting of about twelve thou-

sand choice specimens, intended for the study of mineralogy, and arranged in the manner best adapted for answering that purpose, is, at the same time, one of the most complete that is known. It is recommended by the excellence and interest of the specimens of which it is composed, by the prodigious number of crystals which it contains, and of which the greater number combine with the merit of extreme rarity that of perfect regularity, and by the great advantage of owing its formation and arrangement to the assiduous and enlightened care of M. Haüy. Connoisseurs will especially attach a great degree of importance to a methodical arrangement made by M. Haüy himself, who has classed, named, and labelled them with his own hand, even to the smallest pieces. He has had the patience to place them all upon wooden stands, in which he has fixed them with wax, and thus procured the advantage of having the crystalline forms disposed according to their mutual relations. Each of the stands has, besides, a ticket attached to it, on which are pointed out the name of the variety, its locality, and sometimes even its principal characters; so that the exact summary of all these tickets, or the methodical catalogue of the collection, would itself form a short treatise on the science. At the head of the series relative to the different species, there are specimens which present the primitive form of the substance, or at least the indications of its mechanical division, the effects of refraction, &c. They are those which M. Haüy has employed in the determination of the characters which he calls Specific. Then come the varieties in the order of their greatest perfection, and the specimens which point out the geological relations of the species.

Such a cabinet as this deserves to be preserved as a monument of the science, and it would be worthy of a Government to purchase it, for the purpose of depositing it in an establishment of public instruction.

To the principal collection are attached other accessory collections, equally valuable in themselves as from the views with which they have been formed; such as a numerous suite of rocks, named and arranged mineralogically; a series of precious stones and gems, all mounted in gold; a complete collection of wooden models, for the study of crystallography; and, lastly, the entire assortment of instruments necessary in mineralogy.

M. Haüy, who, in his youth, had successfully cultivated the study of Botany, had composed a herbarium of about eighteen hundred plants of the neighbourhood of Paris, the colours of which he preserved by means of a process of his own invention, so that they are still as fresh, after an interval of more than forty years, as if newly applied to the paper. This herbarium, which is unique of its kind, is also for sale.

Those intending to become purchasers, are requested to address to Monsieur and Madame Vuillemot Haüy, at the Jardin du Roy.

39. *Professor Lenz's Works on Mineralogy*—M. J. G. Lenz, Professor of Philosophy at Jena, founder, in 1797, of the Mineralogical Society of that city, and known by several works relative to mineralogy, received, on the 25th October 1822, the congratulations of his colleagues, on the occasion of his entering the fiftieth year of his professorship, at a solemn festival kept for the purpose. In order to form a right comprehension of the following circumstance, it must be knewn that mineralogists are divided in opinion regarding certain rocks, which the one party attribute to fire, and the other to water. M. Lenz has always shewn a marked attachment to the opinions of the celebrated Werner, and is consequently a zealous Neptunian. Before the place which was to be occupied with the academic banquet was placed the representation of a volcano, figured in relief; and when at table, the volcano at a signal given, vomited up a great number of ducats, and a beautiful gold medal. It was a present from his Serene Highness the Great Duke of Saxe Weimar, to the respectable Professor, who, for once, could not refrain from crying out with the assistants, *Long live the Vulcanists!* We have seen some verses of the celebrated Goethe on the subject, where he exhorts M. Lenz to abjure what he calls the Neptunian heresy. (*All. litter. Zeit. von Hall.* Dec. 1822.)

40. *Non-occurrence of Chalk in the Island of Creta.*—The word Chalk is generally derived from Kreta, and probably the ancients may have used, in place of chalk, the marl found in Creta, the modern Candia; but true chalk occurs no where in that island; on the contrary, it is imported for economical pur-

poses in barrels from Brusa and Magnesia. But a white lime marl, abounding in shells, occurs between the Ida and Lassiter mountain, and, in general, this island is covered with numerous soft, calcareous, and clayey substances of a white colour, hence the modern name *Candia.*—*Siebers' Travels in Candia,* vol. i. p. 208.

ZOOLOGY.

41. *Electricity elicited from the Domestic Cat.*—In addition to the notice in the *Philosophical Journal,* of eliciting sensible shocks of electricity from the body of a cat, I beg to mention, that very distinct discharges may be obtained by touching the tips of the ears, after applying friction to the back. It is very long since I made the experiment, and, at the same time, I remarked the same from the foot. Placing the cat on my knee, I applied the right-hand to the back, the left fore-paw resting on the palm of my left-hand, I applied the thumb to the upper side of the paw, so as to extend the claws, and by this means brought my fore-finger into contact with one of the bones of the leg, where it joins the paw; from the knob or end of this bone, the finger slightly pressing on it, I felt distinctly successive shocks, similar to what were obtained from the ears. It is perhaps unnecessary to say, that in order to this experiment being conveniently performed, the cat must have been from an early period on good terms with the experimenter.

42. *Mammifera of Scandinavia.*—M. Nilsson published at Lund, in 1820, a work on the Mammifera of Scandinavia, in which he describes 74 species, and which he has enriched with observations on the principal anatomical differences peculiar to each species. He has not neglected to mention the bones which occur in the peat-bogs of Scania, some of which belong to animals of more southern countries, as the wild boar, the bison, urus, bear, &c.; while others, such as the elk, the rein-deer, and beaver, are only found now in the northern parts of Sweden.

43. *Swedish Ornithology.*—M. Nilsson, who had already written some papers on the Birds of Sweden, in the Memoirs of the Stockholm Academy, for the years 1816 and 1817, particularly in what concerns the synonymy, has published at Copenhagen, in 1820 and 1821, the two parts of his *Ornithologia*

Suecica, in which he describes 260 species of birds known to be inhabitants of Sweden. This work is distinguished from most others which have preceded it, by details on the manner of living birds, the structure of their nest, the number and aspect of their eggs, their migrations, &c.

44. *Sharks and Rays.*—M. Retzius has printed at Lund a thesis on the Anatomy of the genera Squalus and Raia.

45. *Fossil Tortoises.*—While digging the Gotha Canal, in Ostrogothia, some tortoise shells were found at a depth of 15 feet.

ENTOMOLOGY.

46. *Progress of Entomology in Sweden.*—This branch of zoology is much cultivated in Sweden, but only in as far as regards description and systematic arrangement; few have followed the footsteps of the celebrated De Geer, in studying the metamorphoses and manners of insects.

47. *Insects of Lapland.*—Messieurs Quesnel and Thunberg have determined, either in the Memoirs of the Stockholm Academy, or in the academic dissertations, the insects brought from Lapland.

48. *Synonymy of Insects.*—We are indebted to M. Schœnherr for an important work written in German, but published in Sweden, on the Synonymy of Insects, forming 3 volumes 8vo.

49. *Insects in Amber.*—M. Schweigger having very attentively examined the insects contained in the bits of yellow amber of the coasts of Prussia, and which at first sight might be thought to be the same as the present insects of that country, has found that they in fact often belong to the same genera, but not to the same species as those living at the present day. Among the small number of insects described and figured in the work of this author, we observe, in particular, an unknown species of scorpion, and a spider which differs from all the species living at present, in not having the head of a single piece with the thorax. M. Germar, Professor at Halle, has given the result of a similar investigation in an Entomological Journal, where he tries to determine some species of those amber insects, the analogues of which are not found alive at the present day.

HELMINTHOLOGY.

50. *Earth-worms multiply by Eggs.*—M. Julius Leo, of Berlin, has confirmed, by new observations, what Swammerdam has already said on the subject of earth-worms, namely, that they multiply by eggs, which are found in spring, and which allow not only the inclosed young animal to be seen, but also the circulation of its blood. These observations have been confirmed, (*Isis*, 1820, vol. iv. p. 386.) by M. Rudolphi, according to whom, what some modern naturalists have found in the body of earth-worms, and which they have taken for the living young of these worms, is nothing else than an intestinal worm improperly named *Ascaris lumbrici*, which he refers to the genus *Vibrio*, and which he has found not only in the worms themselves, but also in their eggs.

IV. GENERAL SCIENCE.

51. *Probable origin of certain Salt-springs.*—Mr Amos Eaton has observed, that the water-limestone which forms the roof over the floor of the salt-springs, when exposed in a damp cellar, for two or three weeks, shoots out crystals of common salt, sufficient to cover its whole surface. Hence, he concludes, that the salt springs may have had their origin from water percolating through this stratum of limestone, and that there may be many other kinds of rocks, besides the water-limestone, which contain the elements of common salt.—Professor Silliman's *Journal*, vol. vi. p. 242.

This theory of salt-springs is a very probable one, were it not equally probable that the water-limestone may have derived its salt from the same cause as the springs, or even from the springs themselves.

52. *Method of Cutting Steel by Soft Iron.*—Mr Barnes of Cornwall in America, having occasion to repair a cross-cut saw, recollected of having heard that the Shakers sometimes made use of what he called a buzz to cut iron. He therefore made a circular plate of *soft sheet-iron*, fixed an axis to it, and put it in his lathe, which gave it a very rapid rotatory motion. He then applied to it when in motion a common file to make it perfectly round and smooth, but *the file was cut in two*

by it, while it received itself no impression. He then applied a piece of smoky quartz, which produced the desired effect. He then brought under it the saw plate, which in a few minutes *was neatly and completely cut through longitudinally*. When he stopped the buzz, he found it had not been worn by the operation, and that he could immediately apply his finger to it without perceiving much sensible heat. During the operation there appeared a band of intense fire around the buzz, which continually emitted sparks with great violence. He afterwards marked the saw for the teeth, and in a short time cut them out by the same means.—See Professor Silliman's *Journal*, vol. vi. p. 336, and our last Number, p. 179.

53. *Mr Barton's Iris-Metal Ornaments.*—Having, in a former volume, viz. vol. viii. p. 128., given a full account of Mr Barton's method of making the iris-metal ornaments, our readers will be interested in learning that these are now actually manufactured for sale. We have now before us two sets of gilt buttons, covered with minute lines, forming a pattern, and impressed upon them by a steel die; and we venture to say, that no article of ancient or modern manufacture, can be compared with them in point of beauty. We look forward with great expectations to the application of the same principle to ornaments of female dress; and we are not without hopes of seeing our apartments decorated by the brilliant hues of striated colours.

54. *Destructive Volcanic Eruption in Java.*—About the beginning of November 1822, the mountain in Preanger Regencies, to the south of Sumedang, exploded in a most awful manner, discharging volumes of smoke and flame, and masses of rock, some of which were thrown to a considerable distance, and exceeding twenty feet in diameter. The surrounding country, to the distance of twenty miles, has been completed destroyed, and *six thousand* inhabitants have lost their lives. Great inundations have been produced by the rivers, which were blocked up by the masses of rock thrown from the volcano. The explosion was distinctly heard at Samarang, a distance of more than 150 miles.—*Asiatic Register*, No. xcii. p. 139.

55. *Artificial Mahogany.*—The following method of giving any species of wood of a close grain, the appearance of mahogany

in texture, density and polish, is said to be practised in France, with such success, that the best judges are incapable of distinguishing between the imitation and the mahogany. The surface is first planed smooth, and the wood is then rubbed with a solution of nitrous acid. One ounce and a-half of dragon's blood, dissolved in a pint of spirits of wine, and one-third of an ounce of carbonate of soda, are then to be mixed together and filtered, and the liquid in this thin state is to be laid on with a soft brush. This process is repeated, and in a short interval afterwards the wood possesses the external appearance we have described. When the polish diminishes in brilliancy, it may be restored, by the use of a little cold-drawn lintseed oil.—*London Journal of Arts*, vol. iv. p. 107.

56. *Etching on Glass by Fluoric Acid.*—Professor Silliman, in a paper on this subject, strongly recommends the diluted fluoric acid of Gay Lussac, in preference to the vapour, as being entirely superior in energy, neatness and ease of management. The strong acid is violent and dangerous in the extreme, and should never be allowed to touch the skin, either in the fluid or vaporous state; but the diluted acid may be managed with ease and safety. Still, however, even this sometimes produces sores that last for six weeks. The following is the method of obtaining the acid. Two ounces of pure fluor-spar were introduced into the alembic, and four ounces of sulphuric-acid were added. The apparatus was placed under a flue. The receiver (which was of silver) was kept cold by ice, and when a few live coals was placed beneath the alembic, the acid was disengaged, and was condensed in the receiver without the aid of water. About an ounce of acid was thus obtained. When the acid was wanted for the purposes of etching on glass, the same method was used, only *an ounce* of water was placed in the silver receiver. This acid was still too powerful, as it corroded the varnish used to protect the glass, but it acted in the happiest manner when diluted with three or four parts of water. The best varnish for this purpose is made by melting together common turpentine and bees' wax.—*Amer. Journ. of Science*, vol. vi. No. ii. p. 354.

57. *Important Improvement in Tanning.*—Mr Gybbon Spilsbury of Walsale, Staffordshire, we understand, has succeeded in

reducing the hitherto tedious process of tanning to a very short period. Skins are prepared by his process in nine days, requiring by the old six weeks or two months. Moderately thick hides ⅝th inch thick in six weeks: These take commonly from nine to twelve months. The leather is in every respect equal in strength and toughness, and will be superior to any hitherto produced. There is no difference in the substances employed, but only in the method of applying them. The principle is *pressure*. This important invention has been secured by patents for the three kingdoms.

58. *The Christian Philosopher, or the Connection of Science with Religion.*—A work under this title is on the eve of being published, by Mr Thomas Dick, A. M. of Perth, who is already known to the readers of this Journal, by his curious observations on the planet Venus when near the Sun. This work comprises illustrations of the omnipotence and grandeur of the Deity, and of his wise and benevolent arrangements in the system of Nature,—popular sketches of Natural History, Geography, Geology, Astronomy, Natural Philosophy, Chemistry, Anatomy, and Physiology, embracing an outline of the leading facts connected with these sciences, and illustrating their connection with the objects of religion, and the progress of the human mind. Sketches of some of the inventions of human genius, and of the religious and philanthropic purposes to which they may be applied,—illustrations of several scriptural facts from the system of nature,—and of the beneficial effects which would result from a combination of science with religion. The *general object* of this volume is to lead young and enquiring minds to enlarged conceptions of the attributes, and the incessant agency of the Deity, through the medium of the discoveries which have been made in the system of nature,—to excite them to farther inquiries into the different departments of natural science,—to illustrate the harmony of Science and Revelation,—and to remove those groundless prejudices which a considerable portion of the Christian world still entertain against scientific pursuits.

59. *New Voyage of M. Kotzebue.*—M. Kotzebue is about to set out on a new voyage of discovery round the world, at the expence of the Russian Government, principally with the view of

fixing the positions of the places discovered in his last voyage.' His vessel is about five times larger than the Rurick.—*Journ. des Voyages*, Juillet 1823, p. 125.

Art. XXXVII.—*List of Patents granted in Scotland from 3d June to 18th August 1823.*

13. To Robert Mushet, of the Royal Mint, Towerhill, in the county of Middlesex, gentleman, for an invention of "a mean or means, process or processes, for improving the quality of copper, and of alloyed copper, applicable to the sheathing of ships and other purposes." Sealed at Edinburgh 21st June 1823.

14. To John Green, of Mansfield, county of Nottingham, white-smith, for an improvement "in certain machines used for roving, spinning, and twisting cotton-flax, silk, wool, or other fibrous substances." Sealed at Edinburgh 24th June 1823.

15. To John Bourdieu, Esq. of Lime Street, London, for an invention communicated to him by a stranger residing abroad, "of a mucilage or thickening matter, to be used in printing or colouring linen, woollen, and cotton cloths and silks, in cases in which gums, mucilages, and other thickening matters are now employed." Sealed at Edinburgh 24th June 1823.

16. To Joseph Leigh Bradburgh, of Manchester, county of Lancaster, calico-printer, for an invention of "improvements in the art of printing, painting, or staining silk, cotton, woollen and other cloths, and paper, parchment, vellum, leather, and other substances, by means of blocks or surface-printing." Sealed at Edinburgh 31st July 1823.

17. To William Palmer, of Lothbury, London, paper-hanger, for an invention of certain improvements "in the machinery applicable to printing on calico or other woven fabrics, composed wholly or in part of cotton, linen, wool, or silk." Sealed at Edinburgh 4th August 1823.

18. To Louis John Pouchee, of Queen Street, Holborn, county of Middlesex, type-founder, for an invention communicated by a stranger residing abroad, of "a certain machinery or apparatus, to be used or employed in the casting and making of metal types." Sealed at Edinburgh 12th August 1823.

19. To James Smith of Droitwich, county of Worcester, civil-engineer, for an invention of an "apparatus for the applying of steam for the cooling and concentration of solutions in general, crystallizing the muriate of soda from brines containing that salt, melting and refining of tallow and oils, boiling of sugar, distilling, and other similar purposes." Sealed at Edinburgh 18th August 1823.

20. To William Wigton, of Derby, county of Derby, engineer, for certain "improvements on Steam-engines." Sealed at Edinburgh 18th August 1823.

LIST OF PLATES IN VOL. IX.

INDEX.

A

B

O

P

R

S